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THE EFFECTS OF MULTILAYERED MILITARY CLOTHING ENSEMBLES ON BODY SIZE: A PILOT STUDY

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13. ABSTRACT *(Maximum 200 words)*

This report documents an attempt to quantify the effects of multiple clothing layers on individual body size in order to provide important information to workspace designers and clothing system developers. Over 90 measurements were taken on an anthropometrically diverse sample of five men or five women. The specific clothing ensembles examines in the study include: Ground Soldier, Aviator-Warm Weather, Aviator-Cold Weather, Combat Vehicle Crewman-Warm Weather and Combat Vehicle Crewman-Cold Weather. Semi-nude measurements served as a baseline for the body size increments documented for each successive layer of the clothing ensembles. Initial and repeat measurements of all dimensions were taken in order to assess measurement reliability. In addition, differential donning effects were assessed by measuring subjects in an initial and redress condition. Recommendations for the conduct of a full-scale clothed anthropometric survey are also provided. Finally, a companion study or range of motion under the indentical clothing configurations was conducted and will be presented in a separated report.

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PREFACE

This Technology is one in a series sponsored by the Anthropology Group, Science Directorate, U. S. Army Soldier Systems Command, Natick Research, Development and Engineering Center (NRDEC) to upgrade the anthropomorphic characteristics and capabilities of human body computer models. A related project is reported in Paquette et al., (in press).

A report of this magnitude is not created by its authors alone. The contribution of others is represented herein. Project guidance was provided by Kenneth Parham, Chief, Anthropology and Human Factors Branch, Claire C. Gordon, Senior Scientist, NRDEC, and Bruce Bandtmiller, John T. McConville and Charles E. Clauser, Anthropology Research Project, Inc. (ARP). Ilse O. Tebbetts, Technical Editor, ARP, contributed greatly to the clarity of the prose and the organization of the report. John P. Redgate, Technical Editor, NRDEC, ably assisted with U.S. Army Technical Report style and format. Jennifer A. Schinhofen and Belva M. Hodge (ARP), prepared the initial draft of the report. Donna J. Gaeta, GEO-CENTERS, prepared the final draft.

Finally, any work of this sort is dependent on the subjects, without whom there would be no data. In this case, however, special appreciation is due to our subjects who endured the multiple layers of the cold weather ensembles during the summer in southern Ohio.

THE EFFECTS OF MULTILAYERED MILITARY ENSEMBLES ON BODY SIZE: A PILOT STUDY

CHAPTER 1

INTRODUCTION

Anthropometry, as it is traditionally performed, concerns itself with the physical measurement of the unclothed human body. In the U.S., most major anthropometric surveys have been largely performed on persons wearing minimal clothing (e.g. Clauser et al., 1972; Churchill et al., 1977; Gordon et al., 1989). The resulting data are used in a wide variety of sizing or design problems, most frequently involving clothing or workspace applications. Additional applications include the ergonomic design of industrial equipment, buildings, furniture, vehicles, and personal protective items, among others.

In reality, of course, persons at work are typically not nude. They wear a great variety of clothing ensembles which effectively add to body dimensions, thereby increasing required workspace. The designer must in some way account for the effect of clothing on body size. The influence exerted by office clothing or most factory work clothing on the magnitude of body size is probably of little consequence in many design applications. However, there are clothed conditions, such as multilayered ensembles, in which the increase in body size may affect design. Most notable examples are the pressure-suited astronaut or the "full-up " MOPP (Mission Oriented Protecive Posture) IV soldier who often find that simple activities require considerable space and energy to perform. There are, as well, many civilian workers — farmers, firefighters, foundry workers, cleanroom workers, and chemical and/or hazardous material handlers, for example — who often wear bulky and restrictive protective clothing to work in environmentally hostile conditions. Tools and equipment also must be sized and designed to be used more effectively by the encumbered human operator. Such designs need a clothed anthropometric database from which to draw.

A related use for a clothed anthropometric database is the accurate enfleshment of three-dimensional (3-D) computer models, currently being used in many computer-based solutions to design problems. Most enfleshed models do not include accurate simulation of the effects of clothing ensembles on workspace requirements, and use of such models in Computer Aided Design (CAD) applications may lead to faulty designs.

Still another application of clothed anthropometry (CA) data is the development of patterns for garments to be used in multilayered ensembles. If the order of layers to be worn in a given ensemble is known, the database can be used to estimate incremental grading requirements for the various components. If variation in the sequences occur, then the ease necessary for the worst case increment, which will have to be used for each component, can be estimated from the database.

Studies involving clothed anthropometry are rare. These studies usually describe the establishment of nude landmarks and measurement descriptions but do not discuss how these landmarks are located through heavy clothing or how measurements are made over the clothing. Clothed anthropometric procedures have not been tested to determine whether clothed dimensions can be reliably measured or if the clothed landmarks relate reasonably to the nude ones.

This pilot study, conducted in two phases, had several objectives. In the first phase, appropriate literature was surveyed to identify measuring methods and/or devices that would be useful in a large anthropometric survey of clothed subjects.

Procedures for landmarking and measuring clothed subjects for each of the measuring methods, also had to be developed in Phase 1. Three men and three women of widely diverse heights and weights were measured in selected ensembles to standardize the measuring procedures between members of the measuring team.

This Technical Report gives the results of the Phase 2 testing. During this phase, measurement reliability was evaluated by taking initial and repeat measurements of five male and five female subjects in a variety of multilayered ensembles. The effect of the dressing process on the measurements was also tested for selected ensembles by re-measuring the subjects after they had undressed and redressed in the same ensemble. Finally, the layer-by-layer changes in "body" size for the test ensembles were documented.

In conjunction with this project, MOCO, Inc. of North Scituate, MA, conducted a companion study to determine the effects of the same ensembles on range of joint motion (ROJM). The overall experimental design used in the ROJM study paralleled the present CA study. The methods and devices used and the results obtained are reported in a separate Technical Report (Paquette et al., in press).

BACKGROUND AND LITERATURE REVIEW OF CLOTHED ANTHROPOMETRY

The military services were the first to recognize the need for information on the decremental effect of clothing on mobility and performance. Although traces of interest can be found in many textbooks, the referenced works come largely from the military or from research funded by the U.S. Department of Defense. Among the early investigators in the area of clothed anthropometry, Roberts (1945) looked at the workspace requirements for nine different U.S. Army clothing combinations. No attempt was made to standardize measuring procedures; hence, large variations were observed due to the way the clothes were fitted. The same year, Hooton (1945) published his survey of seating dimensions for railway car design in which the subjects were measured in the clothed condition. It was probably this survey along with one performed on U.S. Army Air Corps (Randall et.al., 1946) personnel that ultimately led to the widespread use of applied anthropometry in the military. Randall and co-workers (1946) tested the effect of

heavy flight clothing on the ability of fliers to fit into B-29 gun turrets. Body size increments due to some early flight clothing reported by these investigators are presented in Table 1. These data were among the first reported on clothed anthropometry.

During the 1950's and 1960's Kobrick (1956a, b; 1957a, b) Kobrick and Crist (1960), White et al. (1964), and Johnson (1984) examined increases in body size due to wearing U.S. Army clothing. Meanwhile, the Air Force was also researching the effect of flight clothing on body size and function (Alexander et al., 1964; Alexander et al., 1969; Alexander et al., 1970; Garrett, 1968; and Middleton et al., 1970). A summary table covering much of the early work may be found in Webb (1964).

A smattering of published work on the effect of clothing on body size followed these early investigations. Perhaps the most useful data were those published by Khandkar et al. (1980). In this study the authors document body size differences in summer combat and Arctic/winter clothing used by the Canadian Forces.

Anthropology Research Project (ARP) has been involved in numerous projects requiring measurement of clothed subjects. One such was enfleshment of CREW CHIEF, the USAF's 3-D model of an aircraft maintenance technician, for whom ARP personnel collected clothed anthropometric data (Daziens et al., 1989).

TABLE 1

AMOUNTS ADDED TO NUDE DIMENSIONS BY TYPICAL CLOTHING OUTFITS
(from Randall et al., 1946)
(weight in pounds, all others in inches)

DIMENSION	HEAVY WINTER FLYING CLOTHING[1]	ELECTRICALLY HEATED SUIT (OLD TYPE)[2]	QUILTED SUIT[3]	ELECTRICALLY HEATED SUIT (NEW TYPE)[4]
Weight	20.0	16.0	14.0	15.5
Stature	1.9	1.8	1.9	1.2
Trunk Height	0.6	0.5	0.7	0.5
Sitting Height	0.2	0.2	0.2	0.2
Head Height	0.2	0.2	0.2	0.2
Sitting Ht Minus Head Ht	0.4	0.4	0.4	0.4
Buttock-Knee	0.5	0.4	1.1	0.3
Patella Height	1.8	1.6	2.2	1.9
Total Span	0.4	0.2	0.0	0.0
Span Akimbo	0.8	0.4	0.0	0.0
Anterior Arm Reach	0.4	0.2	0.0	0.0
Shoulder-Elbow Height	0.3	0.5	0.3	0.5
Biacromial Breadth	1.3	0.4	0.8	0.2
Bideltoid Breadth	0.7	0.5	0.8	0.2
Chest Breadth	0.6	0.4	0.6	0.5
Elbow Breadth	4.4	2.4	4.7	2.9
Chest Depth	1.4	0.7	1.7	0.7
Abdominal Depth	1.4	0.4	2.2	0.8
Bi-iliac Breadth	1.3	0.4	2.1	0.8
Bitrochanteric Breadth	1.7	0.5	2.5	0.6
Knee Breadth	2.5	2.5	2.1	1.0
Squatting Diagonal	2.9	1.0	...	...
Hand Length	0.3	0.4	0.4	0.2
Hand Breadth	0.4	0.2	0.3	0.2
Foot Length[5]	2.7	2.7	2.7	2.7
Foot Breadth[5]	1.2	0.7	0.9	0.9
Calf Circumference	6.0	1.6	3.9	1.8
Chest Circumference	9.1	4.4	6.8	3.4
Head Length	0.4	0.4	0.4	0.4
Head Breadth	0.4	0.4	0.4	0.4
Head Circumference	1.7	1.7	1.7	1.7

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1 B-3 jacket, A-3 trousers, B-5 helmet, A-9 gloves, A-6 boots
2 F-1 suit, B-5 helmet, A-6 gloves, A-9 boots
3 SJ-4 jacket, ST-9 trousers, B-6 helmet, A-9 gloves, A-6 boots
4 PA-17-LI jacket, PA-17-MI trousers, B-6 helmet, PA-17-DI gloves, A-6 boot, A-4 coverall
5 Measurements; A-6 boot, medium; 12.8" long, 5.0" wide: A-6, large; 13.5" long, 5.3" wide: A-9, large; 13.2" long, 4.7" wide

CHAPTER 2

MATERIALS AND METHODS

SUBJECTS

Ten subjects were used in Phase 2. Subjects were chosen to represent a wide range of body size. The subjects' height and weight are shown with corresponding percentiles from the 1988 U.S. Army anthropometric survey (ANSUR) (Gordon et al., 1989) in Table 2.

TABLE 2

STATURE AND WEIGHT OF CLOTHED SUBJECTS
AND THEIR EQUIVALENT PERCENTILES IN ANSUR
(stature in mm, weight in hg)

	STATURE		WEIGHT	
SUBJECT SIZE DESIGNATION	CLOTHED SUBJECTS	ANSUR %ILE	CLOTHED SUBJECTS	ANSUR %ILE
		FEMALES		
Extra-Small	1528	5	510	7
Small	1593	30	559	24
Medium	1621	46	622	54
Large	1677	78	656	70
Extra-Large	1769	98	786	96
		MALES		
Extra-Small	1677	12	643	9
Small	1685	14	674	16
Medium	1725	33	754	42
Large	1823	83	817	63
Extra-Large	1814	81	962	93

A subject's measurements may vary from day to day or even within a single day for a variety of reasons. Weight, for example, can differ by two pounds or more within a single day, depending on the fullness of the bowels and bladder, the amount of food and fluid intake, and the amount of evaporative loss from perspiration that has occurred. In addition, weight can vary substantially over the course of several weeks.

Stature and other height-related dimensions also vary during the day, apparently due to the effects of fatigue and gravity. Individuals tend to be taller early in the day after a good night's rest. Day-to-day variation is less well understood, but presumably can be affected by such factors as the amount of rest received the previous night, sickness, hangovers, and self-esteem.

A log of nude stature and weight, measured at the beginning of each session, was kept on each subject so within-subject anthropometric variation could be tracked throughout the course of the study. Variation in measurements between days reflect differences in measuring and real daily differences in the subject. Weight, the more variable of the two dimensions, differs by more than 20 hg for many of the subjects. Stature is reasonably stable, but varied by more than 10 mm on a few occasions. These values are indicative of the magnitude of nude variation that can be expected for some individuals when working with the same subject over a period of several weeks.

CLOTHING ENSEMBLES

Both the men and women were measured wearing the Ground Soldier (GS), the Aviator Warm Weather (AWW) and the Aviator Cold Weather (ACW) ensembles. The men were also measured in the Combat Vehicle Crewman Warm Weather (CVCWW) and Combat Vehicle Crewman Cold Weather (CVCCW) clothing. The subjects were measured in all layers of each ensemble: four layers for the GS; five for the AWW; seven for the ACW; six for the CVCWW, and eight for the CVCCW ensemble. A layer-by-layer list of the clothing items worn in each ensemble, as well as photographs of each layer of the five ensembles, is included in Appendix A.

Tables B-1 through B-8 in Appendix B show the clothing sizes worn by each of the Phase 2 subjects in the five clothing ensembles. Also included in Appendix B is a list of the measuring team's comments regarding the fit of the clothing ensembles for each subject. Note that all sizes of the test items were available for testing, and the subjects were tested in their best fitting garments. Nevertheless, poor garment fit was common, the most frequent comments were that the legs and/or arms of a garment were too long. The excess lengths frequently caused bunching of the material in the lower arm and leg regions, giving a baggy appearance to the clothing. The crotches for some clothing conditions were low on some subjects, often hanging to the level of mid-thigh. The smaller subjects were the most affected by these problems even though they were often fitted into the smallest sizes. On a few occasions, excessively long sleeves and legs were also reported for the larger subjects. In some cases subjects had to wear clothing that was too long in order to accommodate their larger girths.

DIMENSIONS MEASURED

Ninety-two Anthropometric dimensions useful for workspace design, computer modeling, and clothing design were measured on all subjects in the nude condition. Most of these dimensions, with some additions, were measured on subjects in the clothing conditions described above.

A number of heights from the floor were added to the dimensions measured as the principal means of locating measurement landmarks on successive clothing layers. The added heights were coordinated with the location of the circumferences where depths and breadths were also to be measured. That is, for every circumference, a depth and breadth was measured at the same level.

In making the CA measurements, dimensions from a previous layer that were not obscured by the addition of a new layer were not measured for the new condition; the prior value of the measurement was simply brought forward by the database software. That is, only measurements that changed from a previous condition were measured for a given clothing condition. Menton-Sellion Length (face length), for example, was not affected by many of the clothing conditions, and the nude value was automatically transferred through several of the clothing layers.

Data for the nude condition were obtained in connection with the measurements in the GS ensemble and were transferred to the other clothing ensembles. Layer 1, consisting of light underwear, is the same for the GS, AWW, and CVCWW ensembles; it was measured only for the GS ensemble and was transferred to the two remaining ensembles. Likewise, Layers 1 and 2 are the same for the ACW and CVCCW ensembles and were measured only for the ACW ensemble.

ANTHROPOMETRY

The dimensions were measured using the following instruments: anthropometer, beam caliper, spreading caliper, sliding caliper, tape, Holtain caliper, and the NATO headboard with a headboard gauge.

Nude or Lightly Clothed Measuring Techniques

Nude dimensions measured on each subject served as baselines for comparison with the layers in the clothed ensembles. For this study, "nude" is defined for males as running shorts, and for females as running shorts, bra, and tank top. Anthropometric dimensions are traditionally defined for this lightly clothed condition. The nude landmarks and measurements are fully defined in Appendix C. Most measurement and landmark definitions were drawn from ANSUR (Clauser et al., 1988; Gordon et al., 1989). Many depth and breadth measurements, having no counterparts in the literature, were developed for the study so that for each circumference measured there would be a corresponding depth and breadth measurement. Other principal sources for measurement definitions were the 1968 Air Force anthropometric survey of women (Clauser et al., 1977) and the NATO anthropometric survey of military personnel from Turkey, Greece, and Italy (Hertzberg et al., 1963).

The amount of tension applied to the measuring tape is generally not quantified in published anthropometric studies. Customarily, the feel of what constitutes the correct tension is learned by practicing with experienced anthropometrists. To quantify and standardize the tension between nude and clothed circumferences in this study, a small spring tension scale was attached to the tape. Eighty grams, the average pressure applied by three experienced anthropometrists at ARP, was chosen as representative of the amount of tension applied when measuring nude subjects.

Clothed Measuring Techniques

A survey of the available literature was of little value in helping to develop the methods used for measuring clothed subjects. The few publications dealing with clothed anthropometry generally report the nude anthropometric definitions, but fail to describe how continuity between the nude and clothed conditions was achieved. With little support from the literature, it was necessary to formulate the procedures for conducting clothed anthropometry *de novo*.

One of the most critical issues in establishing CA measurement techniques is the reliable transfer of landmarks from the nude to the clothed conditions. When the clothing was thin, the acromion landmarks could be located by palpation and bustpoint/thelion by visual inspection. For most of the other landmarks, the method selected for transfer rested upon the fundamental assumption that the height of a landmark, when measured on a nude individual, is the same as it will be when he/she is wearing clothes, providing that the time lapse is minimal and the footwear is the same for both sets of measurements. Thus, if heights are measured during each session to the level that nude depths, breadths, and circumferences are measured, it is a simple matter to transfer these heights to the clothing by presetting the anthropometer to the given level and marking the clothing. Tailor's chalk was selected for this purpose since it could be removed from the fabrics without great difficulty.

Midshoulder, Axilla, and Crotch Heights all vary with the addition of clothing, and this change was, of course, measured for each clothing layer. Upper Thigh Circumference, Thigh Depth, and Thigh Breadth were, by definition, measured at the level of the Gluteal Furrow on nude subjects, but as the crotch level dropped with added clothing it was impossible to take these measurements at the level defined for nude subjects. On clothed subjects these measurements were called: Thigh Circumference, Crotch; Thigh Depth, Crotch; and Thigh Breadth, Crotch. They were measured at the crotch level of the clothing and thus were measured lower on the thigh with each successive layer of clothing. The nude dimensions, Midthigh Circumference, Midthigh Depth, Midthigh Breadth, and Midthigh Height, were included in the measuring list so the effects of clothing at a fixed level on the thigh could be determined.

The second major question to be addressed in formulating clothed measuring definitions was whether or not the clothing should be compressed, and if so, by how much. The answer to this question depends on the intended use of the data. As modeling is likely the most important use for the clothed anthropometric data, the measurements should be made, for the most part, on

uncompressed clothing. Additional circumferences, depths, and breadths were measured at the shoulder and hip levels with compressed clothing to help determine the minimum size limits of openings necessary to permit ingress and egress of clothed individuals.

The clothing was allowed to hang naturally and the depths and breadths were easily measurable without compressing the clothing. Circumferences were impossible to measure without compressing the clothing to some degree. If circumferences on completely uncompressed clothing are required, the most practical way of doing this would be to directly measure the width of the clothing while stretched flat on a table and multiply the results by two.

Uncompressed circumferences in this study were defined as those circumferences that were measured with the same tape tension (80 gm), as the nude dimensions. For compressed measurements, the clothing was compressed by pulling the tape tight using, 200 gm of tape tension for light layers of clothing (t-shirt, shorts, and long johns) and 600 gm of tension for heavier layers. These tensions provide adequate clothing compression to estimate the smallest ingress/egress hole needed for the clothed soldier to pass through. After the circumferences were measured on the compressed clothing, the tape was held in position to keep the clothing compressed, and the compressed depths and breadths were measured by placing the blades of the beam caliper over the tape.

All landmark and measurement definitions for the clothed anthropometry are given in Appendix D.

MEASUREMENT PROTOCOL

The same measuring team, consisting of a male and female measurer, was used throughout the entire study. Male subjects were marked and measured by the male team member with the female team member assisting and serving as data recorder. The roles of the team members were reversed when female subjects were measured. Prior to data collection, the measuring team was trained in numerous practice sessions to ensure individual measurement consistency, as well as consistency between measurers.

All measurements of a given clothing layer were completed in a single session. Subjects of both sexes were first measured in the nude condition, followed by the GS, the AWW, and the ACW ensembles. The male subjects were additionally measured in the CVCWW and CVCCW ensembles.

At the beginning of a session, nude stature and weight were measured and recorded in the log book. The subject was landmarked in the nude condition, then dressed, and the landmarks transferred to the clothing. The complete set of relevant initial measurements was made, and then repeated. Selected subjects (the extra-small female, medium female, medium male, and extra-large male for the GS, AWW, and ACW ensembles; and the extra-small male, medium male, and extra-large male for both CVC ensembles) then undressed and redressed. Landmarks were re-marked on the clothing using heights remeasured from the original nude landmarks. In

the redressed conditions the complete set of measurements was measured once more. The initial measurements of a given clothing condition, as well as the repeat and redress measurements were completed within a single session. For those clothing layers that covered a large portion of the body and required a fairly complete set of measurements, a full four-hour session was generally required. Other layers, such as the ballistic vest, added new dimensions only to a portion of the torso and required many fewer measurements. Two of these smaller layers could usually be finished in a session.

DATA ENTRY AND MANAGEMENT

The recorder entered the data onto data sheets as the measurements were called out by the measurer, and the data were then immediately entered into a computer data file. Separate data files, in a spreadsheet format using QUATTRO PRO 4.0, were created for each subject in each clothing ensemble. The difference between a given clothing condition and the previous layer was computed, as were the absolute values of the repeat-measurement deltas. The latter feature was useful for spotting large measuring discrepancies which could be checked and corrected before the subject was dismissed. Since one purpose of the study was to determine the reliability of a variety of clothed measurements, the measurers were instructed not to recheck large measurement differences occurring between the initial and repeat measurements unless it was obvious that the measuring instrument had been misread or the value misrecorded.

DATA ANALYSIS

Because of the small number of subjects, the use of summary statistics to describe measurement parameters were kept to a minimum. Simple mean differences (deltas) and mean absolute differences (MADs), were used to analyze the data. Two broad questions were addressed in the data analysis. The first concerns the reliability of the clothed measuring procedures, and the second relates to the magnitude of change that occurred between the nude condition and the addition of various clothing layers.

Measurement Replications

The replicate measurements show the differences between initial measurements and repeats of the same measurements, and were used to estimate the intraobserver reliability of a particular measuring method. The repeat-measurements analysis was conducted at two different levels.

- First, initial and repeat measurements, using the same landmarks, were measured in close succession and their differences compared. This approach tested primarily the reliability of the measuring techniques.

- Second, initial measurements were compared with measurements made after the subject undressed and then redressed. Landmarks were reestablished after the subject redressed, thus testing a combination of measuring and landmarking. A principal source of variation in this comparison was the dimensional changes that occurred when pieces of clothing were put on differently a second time.

Other sources of error which can confound any interpretation of results include subject fatigue, which changes posture, and shifts in the clothing with accompanying shifts in the landmarks.

Because of the pre-structured sample, summary statistics are not meaningful. For this reason, means and standard deviations of the measured data were not calculated. The focus of the analysis was on the deltas between the initial and repeat measurements for all of the comparisons outlined above. Absolute differences were used, for the most part, since it is the magnitude of the differences rather than their direction which is of interest.

Mean absolute differences were calculated for each sex. Within the constraints of the small sample sizes, these data provide an estimate of the within-subject measuring error that may be expected in a large-scale survey. MAD values by themselves are difficult to evaluate since a given value obviously does not have the same impact for a large dimension as it does for a small one. The MAD expressed as a percent of the mean dimension size eliminates the effect of dimension size, permitting direct comparison of MADs for all dimensions regardless of size.

Measurement Increments between Clothed and Nude Conditions

The second principal area of interest concerns changes in size with the addition of clothing. The change for any clothing condition was measured relative to the nude condition by subtracting the nude value from the clothed value. The signs were retained for the differences since in this case, it is important to know whether certain dimensions increase or decrease with successive layers of clothing.

CHAPTER 3

MEASUREMENT REPLICATIONS: INITIAL VS. REPEAT MEASUREMENTS

Lacking standards for evaluating the repeated measurements of clothed anthropometry, comparison with the repeated measurements of nude (or lightly clothed) subjects taken during ANSUR (Gordon et al., 1989) can be helpful in identifying potential problem areas. Errors for dimensions not measured in ANSUR have not been empirically determined, but the reader should be able to use ANSUR errors for similar measurements taken in close proximity to measured variables as an approximation of the measurement reliability. The measurement error for ANSUR Thigh Circumference, for example, may also be used to compare Thigh Circumference at Crotch and Midthigh Circumference. Likewise, the ANSUR Hip Circumference error may also be applied to Hip Circumference, Compressed in this study.

Interpretation of these comparisons should be made with care. Those variables that fall within the ANSUR nude errors pose no special problem. However, the nude errors, while treated here as a benchmark for lack of any other, should not be used for determining whether or not a particular dimension can be reliably measured for a clothed anthropometric survey. Many, if not most, clothed dimensions cannot be measured with the precision of the nude measurements. Errors of clothed measurements that exceed the nude errors should not automatically be rejected since the clothed measurements in general are expected to show greater variability than nude ones. The concern is whether the variability of repeat measurements are too large to permit confidence in the data.

Tables E-1 through E-8 in Appendix E show the mean absolute differences by sex for the nude and the clothed conditions for each clothing ensemble. The MADs give the average magnitude of deviation between initial and repeat measurements. Tables 3 to 7, showing the MADs as a percent of dimension size (MAD divided by the average of all initial and repeat measurements of a given dimension) for the five clothing ensembles, aid interpretation by eliminating the size component for the various dimensions. The ANSUR observer errors are included for comparison. Males and females are combined for those ensembles in which both sexes were measured. "NA" indicates a dimension was not measured for that layer.

The nude repeated measurements for the clothed anthropometry study correspond favorably with the ANSUR MADs. Nude errors are smaller overall than replications for the clothed anthropometry. This is expected since the procedures for nude or lightly clothed anthropometry are well established, and clothed anthropometry is still more or less in the exploratory stage. Additionally, and probably more importantly, sources of variation for clothed measurements include shifts in the clothing after the subjects are marked and the different ways that clothing can drape on a subject. As a general rule, for both nude and clothed anthropometry, larger dimensions show greater absolute errors than smaller ones, but relative to the dimension size the errors tend to be smaller.

Clothed standing heights generally show small MADs relative to measurement size and nearly all correspond closely with the nude values. Since the initial heights were measured on the nude or lightly clothed body, and then transferred to the clothing with an anthropometer, their variation should be less than dimensions actually measured on the clothed body. The repeat measurements, however, were true clothed measurements. Aside from suggesting good replicability, the small deltas for heights also show that the clothing shifted very little along the vertical axis between the two sets of measurements.

Calf height is an exception to the good measurement replication noted for the clothed height dimensions. Calf Height, in principle, should be one of the easiest heights to replicate, but in practice it was the least repeatable. Several subjects had excessive bunching of material about their lower legs due to the excessive leg lengths of the clothing, and it is probable that the material, and hence the landmarks, shifted between the initial and repeat measurements. With proper trouser lengths it is likely that Calf Height would show better repeatability. The good height replications for other dimensions show that transferring nude heights to the clothed condition for establishing circumference, depth, and breadth levels is a reasonable approach.

Depths, breadths, and circumferences of the torso showed good repeatability. Chest Depth is a notable exception with many MADs of 5 to 7 mm, that accounted for roughly 2.5 to 3.5 percent of the total size variability. The clothing on the back at this level can either puff out or lie flat, and measuring these two conditions without compressing the clothing could result in large deltas. The chest region can be complex in terms of the clothing configuration: the hood for the chemical defense mask, which can assume a number of shapes, and the pockets of the SARVIP and SRU-21/P Survival Vest made measuring in this region difficult. For some measurements, the large mean absolute deltas can be attributed to poor replications in one or two subjects.

Measurements of the head, hands, and feet tend to show good replicability. Depths and breadths of the arms and legs, on the other hand, show poor correspondence between the initial and repeat measurements when compared with the ANSUR nude percentages. Bunching of the material about the lower legs has already been mentioned as a problem. This can also occur about the lower arms, and even around the biceps when the arm is flexed. The sleeves and legs of the clothing often fit loosely on the limbs and can assume a wide variety of shapes. Depths and breadths measured without compressing the material can be expected to show great variability. The repeatability of circumferences of the arms and legs are generally acceptable, although they tend to show proportionately larger errors than the larger circumferences of the torso. This is probably due to the greater number of ways that excess material covering the limbs can be compressed.

Overall the replications are reasonably good. A few of the large deltas are probably due to measurement or recording errors within one or two individuals. In an anthropometric survey many of the spurious measurements could be identified and eliminated in the field by using a good editing routine in conjunction with the data entry program. Thus, we might expect measuring performance on an actual anthropometric survey to be somewhat better than in this study. The increased variability for most of the remaining dimensions reflect the variability that

can be expected when measuring the clothed body. For example, Forearm Depth, Flexed and Forearm Breadth, Flexed shows large MADs relative to the total size of the measurements for Layer 3 of the GS ensemble (see Table 3). These measurements are extremely hard to replicate because of the large and sloppy fit of the sleeves. As noted previously, many other dimensions of the arms and legs also suffer from the same problem and, generally speaking, smaller circumferences, depths, and breadths show proportionately greater variation than the larger ones on clothing.

The relativety low repeatability of the depths and breadths of the arms and legs probably does not pose a serious problem. Most of these dimensions were not measured in ANSUR or most other surveys, but were included here as being potentially useful for enfleshing computer models. Replication of the clothed measurements that had analogous ANSUR measurements are probably acceptable for the most part, but there will almost always be more variability in clothed anthropometry than we are accustomed to in nude anthropometry.

TABLE 3

REPEATED MEASURES BY LAYER COMPARED TO ANSUR
MEAN ABSOLUTE DIFFERENCE AS A PERCENT OF MEAN SIZE
GROUND SOLDIER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	0.8	0.5	0.7	0.3	0.7	0.8
Acromion Height	0.2	0.3	0.3	0.3	0.3	0.2
Acromion-Radiale Length	0.4	0.6	NA	NA	NA	NA
Ankle Breadth	NA	1.8	0.0	1.1	2.5	NA
Ankle Circumference	0.6	0.5	0.9	0.5	1.4	NA
Ankle Depth	NA	0.0	1.3	1.0	2.6	NA
Ankle Height	NA	0.8	1.3	1.0	1.6	NA
Axilla (Scye) Height	0.2	0.3	0.4	0.4	0.6	0.5
Ball of Foot Circumference	0.8	0.4	0.4	0.3	0.6	NA
Ball of Foot Length	0.4	1.1	0.8	0.5	0.9	NA
Biacromial Breadth	0.9	0.5	1.2	0.7	2.4	1.1
Biceps Breadth, Flexed	NA	3.0	2.4	3.8	2.6	NA
Biceps Circumference, Flexed	0.7	0.7	0.8	1.6	1.8	NA
Biceps Depth, Flexed	NA	0.9	2.8	5.2	3.0	NA
Bideltoid Breadth, Compressed	NA	NA	0.8	0.6	1.1	0.9
Bideltoid Breadth, Uncompressed	0.8	0.7	1.0	0.9	1.7	1.0
Bimalleolar Breadth	0.9	1.5	0.7	1.8	2.3	NA
Bitragion (Ear Cup) Breadth	NA	0.7	NA	0.4	NA	NA
Buttock Circumference, Comp	NA	NA	0.6	0.6	0.4	NA
Buttock Circumference, Uncomp	0.4	0.2	0.5	0.4	0.6	NA
Buttock Depth, Compressed	NA	NA	1.8	1.5	1.6	NA
Buttock Depth, Uncompressed	1.7	2.0	1.8	3.1	3.3	NA
Buttock Height	0.2	0.1	0.3	0.3	0.2	NA
Buttock-Knee Length	0.6	0.4	0.8	0.7	1.0	1.0
Buttock-Popliteal Length	1.0	0.7	0.7	1.4	1.7	1.5
Calf Breadth	NA	1.3	1.3	3.4	3.2	NA
Calf Circumference	0.4	0.3	0.3	1.4	2.8	NA
Calf Depth	NA	0.4	0.4	5.2	2.5	NA
Calf Height	0.3	0.2	0.6	0.5	1.6	NA
Chest Breadth	1.0	0.7	1.8	1.7	1.5	1.6
Chest Circumference	0.7	0.8	0.6	0.9	1.2	0.6
Chest Depth	1.2	0.6	1.6	1.9	3.4	1.6
Chest Depth - Deltoid Pt, Comp.	NA	NA	1.9	2.1	2.3	2.0
Chest Depth - Deltoid Pt, Uncomp.	NA	0.9	1.4	2.0	3.0	1.9
Chest Height	0.3	0.4	0.2	0.4	0.6	0.3
Crotch Height	0.7	0.5	0.5	0.6	1.0	NA
Deltoid Point Height	NA	0.3	0.3	0.2	0.4	0.3
Ectoorbitale-Top of Head	NA	1.3	NA	2.4	1.6	NA

TABLE 3 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Elbow Breadth	NA	2.2	NA	4.0	6.8	NA
Elbow Circumference	0.5	0.6	NA	1.4	2.0	NA
Elbow Depth	NA	1.6	NA	3.3	4.9	NA
Eye Height, Sitting	0.6	0.5	0.5	0.6	0.4	NA
Foot Breadth Horizontal	0.6	1.0	1.0	1.0	0.8	NA
Foot Length	0.2	0.4	0.2	0.2	0.5	NA
Forearm Breadth, Flexed	NA	1.8	NA	3.8	4.0	NA
Forearm Circumference, Flexed	0.9	1.1	NA	1.9	1.5	NA
Forearm Depth, Flexed	NA	2.2	NA	4.9	4.6	NA
Glabella-Helmet Rim	NA	NA	NA	2.4	NA	NA
Hand Breadth	0.4	0.6	NA	NA	2.3	NA
Hand Circumference	0.4	1.0	NA	NA	1.4	NA
Hand Length	0.6	0.8	NA	NA	2.1	NA
Hand Thickness	NA	1.8	NA	NA	4.7	NA
Head (Helmet) Breadth	0.3	0.7	NA	0.2	NA	NA
Head (Helmet) Length	0.3	0.5	NA	0.0	NA	NA
Head (Helmet) Circumference	0.1	0.3	NA	0.2	NA	NA
Heel Breadth	1.5	1.5	1.4	1.1	1.0	NA
Helmet Rim-Top of Head	NA	NA	NA	2.6	1.4	NA
Hip Breadth, Compressed	NA	NA	0.6	1.0	1.1	NA
Hip Breadth, Uncompressed	0.6	0.7	0.8	2.4	1.3	NA
Knee Breadth	NA	0.9	NA	3.6	3.7	NA
Knee Circumference	0.6	0.7	NA	1.5	2.4	NA
Knee Depth	NA	0.4	NA	4.6	3.2	NA
Knee Height, Midpatella	0.5	0.3	0.4	0.9	1.4	NA
Knee Height, Sitting	0.1	0.1	0.3	0.4	0.4	NA
Lateral Femoral Epicondyle Ht.	0.3	0.2	0.2	0.3	0.9	NA
Lateral Malleolus Height	1.1	1.5	1.5	0.9	2.2	NA
Menton-Sellion Length	0.9	1.3	NA	1.7	0.9	NA
Menton-Top of Head	NA	0.4	NA	1.6	0.6	NA
Midshoulder Height	NA	0.2	0.2	0.2	0.3	0.2
Midshoulder Height, Sitting	0.6	0.4	0.7	0.4	1.2	0.5
Midthigh Breadth	NA	1.2	NA	2.4	2.7	NA
Midthigh Circumference	NA	0.5	NA	1.3	1.9	NA
Midthigh Depth	NA	1.4	NA	2.2	2.4	NA
Midthigh Height	NA	0.1	0.2	0.5	0.9	NA
Neck Breadth	NA	1.8	NA	2.1	3.1	2.9
Neck Circumference	0.9	0.6	NA	1.1	0.9	0.7
Neck Depth	NA	1.0	NA	1.3	4.6	3.4
Neck Height, Lateral	0.2	0.1	0.1	0.2	0.2	0.2
Popliteal Height	0.6	0.1	0.4	2.2	1.3	NA
Radiale-Stylion Length	1.1	1.0	NA	NA	NA	NA
Sellion-Back of Head	NA	0.5	NA	0.5	0.4	NA
Sellion-Top of Head	NA	1.9	NA	1.4	1.7	NA
Shoulder Circumference, Comp.	NA	NA	0.5	0.6	0.8	0.7

TABLE 3 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Shoulder Circumference, Uncomp.	0.5	0.7	0.5	0.5	0.7	0.8
Sitting Height	0.3	0.3	0.2	0.3	0.5	NA
Stature	0.2	0.2	0.1	0.2	0.1	0.2
Thigh Breadth, Crotch	NA	2.2	NA	1.7	1.4	NA
Thigh Circumference, Crotch	NA	0.6	NA	0.8	0.9	NA
Thigh Clearance	0.9	0.9	NA	1.3	1.7	NA
Thigh Depth, Crotch	NA	1.5	NA	2.3	3.9	NA
Trochanteric Height	0.2	0.3	0.3	0.3	0.3	NA
Vertical Trunk Circ (ASCC)	0.7	0.4	0.6	0.4	0.9	0.6
Waist Breadth	0.7	1.0	1.4	1.8	2.1	1.1
Waist Circumference, Omphalion	0.5	0.4	0.9	0.5	1.5	0.3
Waist Depth	1.1	1.4	1.5	3.7	2.6	0.7
Waist Height, Omphalion	0.3	0.4	0.4	0.4	0.3	0.2
Weight	0.0	0.1	0.0	0.1	0.1	0.1
Wrist Breadth	NA	1.8	NA	1.9	1.7	NA
Wrist Circumference	0.8	0.9	NA	1.0	1.3	NA
Wrist Depth	NA	1.3	NA	3.1	3.9	NA

TABLE 4

REPEATED MEASURES BY LAYER COMPARED TO ANSUR
MEAN ABSOLUTE DIFFERENCE AS A PERCENT OF MEAN SIZE
AVIATOR WARM WEATHER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	0.8	0.5	0.7	0.9	0.5	0.5	0.5
Acromion Height	0.2	0.3	0.3	0.2	0.2	0.2	0.3
Acromion-Radiale Length	0.4	0.6	NA	NA	NA	NA	NA
Ankle Breadth	NA	1.8	0.0	5.5	NA	NA	2.2
Ankle Circumference	0.6	0.5	0.9	0.9	NA	NA	0.9
Ankle Depth	NA	0.0	1.3	7.3	NA	NA	2.3
Ankle Height	NA	0.8	1.3	2.3	NA	NA	1.5
Axilla (Scye) Height	0.2	0.3	0.4	0.4	0.6	0.6	0.6
Ball of Foot Circumference	0.8	0.4	0.4	NA	NA	NA	NA
Ball of Foot Length	0.4	1.1	0.8	NA	NA	NA	NA
Biacromial Breadth	0.9	0.5	1.2	0.4	0.8	1.4	1.8
Biceps Breadth, Flexed	NA	3.0	2.4	4.6	5.8	NA	2.7
Biceps Circumference, Flexed	0.7	0.7	0.8	1.0	1.7	NA	1.7
Biceps Depth, Flexed	NA	0.9	2.8	6.7	4.0	NA	4.5
Bideltoid Breadth, Compressed	NA	NA	0.8	0.5	0.7	NA	0.8
Bideltoid Breadth, Uncompressed	0.8	0.7	1.0	0.8	0.4	NA	1.3
Bimalleolar Breadth	0.9	1.5	0.7	6.8	NA	NA	2.6
Bitragion (Ear Cup) Breadth	NA	0.7	NA	NA	NA	NA	NA
Buttock Circumference, Comp	NA	NA	0.6	0.5	NA	0.6	0.5
Buttock Circumference, Uncomp	0.4	0.2	0.5	0.4	NA	0.4	0.7
Buttock Depth, Compressed	NA	NA	1.8	1.0	NA	1.9	1.6
Buttock Depth, Uncompressed	1.7	2.0	1.8	1.4	NA	1.2	2.3
Buttock Height	0.2	0.1	0.3	0.3	NA	0.5	0.4
Buttock-Knee Length	0.6	0.4	0.8	0.8	0.9	NA	0.7
Buttock-Popliteal Length	1.0	0.7	0.7	2.1	2.5	NA	1.5

TABLE 4 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Calf Breadth	NA	1.3	1.3	4.0	NA	NA	2.2
Calf Circumference	0.4	0.3	0.3	1.4	NA	NA	2.0
Calf Depth	NA	0.4	0.4	6.5	NA	NA	5.1
Calf Height	0.3	0.2	0.6	0.4	NA	NA	0.4
Chest Breadth	1.0	0.7	1.8	1.8	2.0	1.6	1.5
Chest Circumference	0.7	0.8	0.6	0.9	0.8	0.5	0.5
Chest Depth	1.2	0.6	1.6	3.3	2.6	1.4	1.8
Chest Depth - Deltoid Pt, Comp.	NA	NA	1.9	2.4	2.5	0.8	1.3
Chest Depth - Deltoid Pt, Uncomp.	NA	0.9	1.4	1.6	2.3	1.5	1.4
Chest Height	0.3	0.4	0.2	0.2	0.3	0.4	0.3
Crotch Height	0.7	0.5	0.5	0.6	NA	0.7	0.9
Deltoid Point Height	NA	0.3	0.3	0.3	0.3	0.3	0.3
Ectoorbitale-Top of Head	NA	1.3	NA	1.5	NA	NA	1.4
Elbow Breadth	NA	2.2	NA	4.5	2.1	NA	2.7
Elbow Circumference	0.5	0.6	NA	1.0	2.4	NA	2.4
Elbow Depth	NA	1.6	NA	5.9	5.5	NA	4.4
Eye Height, Sitting	0.6	0.5	0.5	0.6	NA	NA	0.6
Foot Breadth Horizontal	0.6	1.0	1.0	NA	NA	NA	NA
Foot Length	0.2	0.4	0.2	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	1.8	NA	4.1	5.0	NA	2.7
Forearm Circumference, Flexed	0.9	1.1	NA	1.3	1.8	NA	1.9
Forearm Depth, Flexed	NA	2.2	NA	5.1	4.9	NA	1.9
Glabella-Helmet Rim	NA	NA	NA	2.1	NA	NA	16.7
Hand Breadth	0.4	0.6	NA	1.1	NA	NA	NA
Hand Circumference	0.4	1.0	NA	0.5	NA	NA	NA
Hand Length	0.6	0.8	NA	1.0	NA	NA	NA
Hand Thickness	NA	1.8	NA	5.9	NA	NA	NA
Head (Helmet) Breadth	0.3	0.7	NA	NA	NA	NA	NA
Head (Helmet) Length	0.3	0.5	NA	NA	NA	NA	NA
Head (Helmet) Circumference	0.1	0.3	NA	NA	NA	NA	NA
Heel Breadth	1.5	1.5	1.4	NA	NA	NA	NA

TABLE 4 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Helmet Rim-Top of Head	NA	NA	NA	1.1	NA	NA	2.3
Hip Breadth, Compressed	NA	NA	0.6	0.9	NA	NA	1.5
Hip Breadth, Uncompressed	0.6	0.7	0.8	1.2	NA	NA	1.5
Knee Breadth	NA	0.9	NA	3.8	NA	NA	2.9
Knee Circumference	0.6	0.7	NA	1.6	NA	NA	1.4
Knee Depth	NA	0.4	NA	4.3	NA	NA	3.4
Knee Height, Midpatella	0.5	0.3	0.4	0.9	NA	NA	0.7
Knee Height, Sitting	0.1	0.1	0.3	0.5	NA	NA	0.4
Lateral Femoral Epicondyle Ht.	0.3	0.2	0.2	0.5	NA	NA	0.3
Lateral Malleolus Height	1.1	1.5	1.5	2.4	NA	NA	1.8
Menton-Sellion Length	0.9	1.3	NA	NA	NA	NA	0.6
Menton-Top of Head	NA	0.4	NA	1.1	NA	NA	0.9
Midshoulder Height	NA	0.2	0.2	0.2	0.2	0.3	0.3
Midshoulder Height, Sitting	0.6	0.4	0.7	0.5	0.4	0.5	0.9
Midthigh Breadth	NA	1.2	NA	2.7	NA	NA	1.5
Midthigh Circumference	NA	0.5	NA	1.0	NA	NA	1.1
Midthigh Depth	NA	1.4	NA	2.8	NA	NA	2.8
Midthigh Height	NA	0.1	0.2	0.3	NA	NA	0.5
Neck Breadth	NA	1.8	NA	2.0	3.1	NA	2.7
Neck Circumference	0.9	0.6	NA	1.0	1.6	NA	0.8
Neck Depth	NA	1.0	NA	2.5	1.2	NA	1.9
Neck Height, Lateral	0.2	0.1	0.1	0.1	0.1	0.1	0.3
Popliteal Height	0.6	0.1	0.4	1.4	NA	NA	0.7
Radiale-Stylion Length	1.1	1.0	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	0.5	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	1.9	NA	1.9	NA	NA	0.9
Shoulder Circumference, Comp.	NA	NA	0.5	0.3	0.7	0.6	1.0
Shoulder Circumference, Uncomp.	0.5	0.7	0.5	0.5	0.6	0.5	0.8
Sitting Height	0.3	0.3	0.2	0.2	NA	NA	0.2
Stature	0.2	0.2	0.1	0.1	0.2	0.1	0.2
Thigh Breadth, Crotch	NA	2.2	NA	2.6	NA	NA	1.7

TABLE 4 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Thigh Circumference, Crotch	NA	0.6	NA	0.6	0.6	1.3	1.0
Thigh Clearance	0.9	0.9	NA	1.4	NA	NA	1.2
Thigh Depth, Crotch	NA	1.5	NA	3.1	NA	2.8	2.7
Trochanteric Height	0.2	0.3	0.3	0.3	NA	NA	0.2
Vertical Trunk Circ (ASCC)	0.7	0.4	0.6	0.6	0.5	0.8	0.5
Waist Breadth	0.7	1.0	1.4	1.1	2.0	1.1	1.0
Waist Circumference, Omphalion	0.5	0.4	0.9	0.5	1.2	0.6	0.4
Waist Depth	1.1	1.4	1.5	2.2	2.2	1.7	1.4
Waist Height, Omphalion	0.3	0.4	0.4	0.1	0.3	0.2	0.3
Weight	0.0	0.1	0.0	0.1	0.1	0.1	0.0
Wrist Breadth	NA	1.8	NA	3.4	2.8	NA	2.2
Wrist Circumference	0.8	0.9	NA	1.8	0.8	NA	1.3
Wrist Depth	NA	1.3	NA	6.0	2.7	NA	3.8

TABLE 5

REPEATED MEASURES BY LAYER COMPARED TO ANSUR
MEAN ABSOLUTE DIFFERENCE AS A PERCENT OF MEAN SIZE
AVIATOR COLD WEATHER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	0.8	0.5	0.4	0.9	0.5	0.7	0.5	NA	0.8
Acromion Height	0.2	0.3	0.3	NA	0.3	0.3	0.2	0.2	0.3
Acromion-Radiale Length	0.4	0.6	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	NA	1.8	2.2	5.0	2.7	2.0	NA	NA	2.3
Ankle Circumference	0.6	0.5	1.1	1.6	1.2	1.2	NA	NA	0.5
Ankle Depth	NA	0.0	1.8	4.7	4.3	2.3	NA	NA	3.0
Ankle Height	NA	0.8	0.9	0.8	1.0	0.7	NA	NA	2.2
Axilla (Scye) Height	0.2	0.3	NA	0.6	0.5	0.5	0.4	0.5	0.5
Ball of Foot Circumference	0.8	0.4	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	0.4	1.1	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	0.9	0.5	NA	0.7	0.7	NA	0.7	0.7	1.1
Biceps Breadth, Flexed	NA	3.0	NA	3.0	3.6	NA	2.1	NA	2.6
Biceps Circumference, Flexed	0.7	0.7	NA	1.6	1.6	NA	1.2	NA	1.2
Biceps Depth, Flexed	NA	0.9	NA	5.8	3.0	NA	2.7	NA	1.8
Bideltoid Breadth, Compressed	NA	NA	NA	1.0	0.7	NA	0.6	NA	0.5
Bideltoid Breadth, Uncompressed	0.8	0.7	NA	1.0	0.5	NA	1.0	NA	1.0
Bimalleolar Breadth	0.9	1.5	2.1	5.9	4.0	2.1	NA	NA	2.7
Bitragion (Ear Cup) Breadth	NA	0.7	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Comp	NA	NA	0.5	0.4	0.4	0.5	NA	0.8	0.3
Buttock Circumference, Uncomp	0.4	0.2	0.4	0.4	0.4	0.4	NA	0.5	0.5
Buttock Depth, Compressed	NA	NA	2.3	1.7	1.4	0.8	NA	2.3	0.8
Buttock Depth, Uncompressed	1.7	2.0	1.9	2.3	1.2	1.4	NA	2.2	1.0
Buttock Height	0.2	0.1	0.3	0.4	0.4	0.3	NA	0.3	0.5
Buttock-Knee Length	0.6	0.4	0.6	0.8	0.7	1.1	0.8	0.9	0.6
Buttock-Popliteal Length	1.0	0.7	1.1	1.5	1.1	2.1	1.1	1.2	1.7

TABLE 5 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Calf Breadth	NA	1.3	0.8	3.7	3.5	2.8	NA	NA	1.5
Calf Circumference	0.4	0.3	0.3	1.4	1.1	0.8	NA	NA	0.8
Calf Depth	NA	0.4	0.4	4.3	2.7	2.3	NA	NA	1.9
Calf Height	0.3	0.2	0.9	0.8	0.4	0.7	NA	NA	0.8
Chest Breadth	1.0	0.7	NA	3.0	1.7	NA	1.7	0.9	1.6
Chest Circumference	0.7	0.8	NA	0.8	0.5	0.7	1.0	0.3	0.4
Chest Depth	1.2	0.6	NA	2.3	1.1	1.4	1.7	1.8	1.2
Chest Depth - Deltoid Pt, Comp.	NA	NA	NA	2.3	2.4	2.6	2.6	2.2	1.2
Chest Depth - Deltoid Pt, Uncomp.	NA	0.9	NA	1.1	1.7	1.0	1.7	1.4	0.6
Chest Height	0.3	0.4	NA	0.4	0.2	0.2	0.3	0.2	0.2
Crotch Height	0.7	0.5	0.6	0.7	0.7	0.7	NA	0.6	0.8
Deltoid Point Height	NA	0.3	NA	0.2	0.4	0.2	0.2	0.2	0.3
Ectoorbitale-Top of Head	NA	1.3	NA	NA	NA	NA	NA	NA	NA
Elbow Breadth	NA	2.2	NA	5.4	2.8	NA	2.7	NA	2.5
Elbow Circumference	0.5	0.6	NA	1.9	1.6	NA	1.3	NA	0.9
Elbow Depth	NA	1.6	NA	5.3	3.5	NA	1.7	NA	1.8
Eye Height, Sitting	0.6	0.5	0.4	0.4	0.6	0.6	NA	NA	0.5
Foot Breadth Horizontal	0.6	1.0	NA	NA	NA	NA	NA	NA	NA
Foot Length	0.2	0.4	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	1.8	NA	4.5	2.8	NA	3.1	NA	3.0
Forearm Circumference, Flexed	0.9	1.1	NA	2.4	1.9	NA	1.5	NA	1.1
Forearm Depth, Flexed	NA	2.2	NA	4.6	2.2	NA	2.8	NA	2.5
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	0.4	0.6	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	0.4	1.0	NA	NA	NA	NA	NA	NA	NA
Hand Length	0.6	0.8	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	1.8	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	0.3	0.7	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	0.3	0.5	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Circumference	0.1	0.3	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	1.5	1.5	NA	NA	NA	NA	NA	NA	NA

TABLE 5 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	NA	NA	1.1	0.4	0.8	0.8	NA	NA	0.6
Hip Breadth, Uncompressed	0.6	0.7	0.8	0.7	0.7	0.7	NA	NA	0.7
Knee Breadth	NA	0.9	1.2	2.3	3.4	2.4	NA	NA	2.0
Knee Circumference	0.6	0.7	1.5	1.8	1.3	0.8	NA	NA	0.5
Knee Depth	NA	0.4	2.4	4.3	4.2	2.3	NA	NA	2.5
Knee Height, Midpatella	0.5	0.3	0.6	0.7	0.9	0.5	NA	NA	0.6
Knee Height, Sitting	0.1	0.1	0.4	0.5	0.2	0.4	NA	NA	0.3
Lateral Femoral Epicondyle Ht.	0.3	0.2	0.5	0.6	0.5	0.4	NA	NA	0.3
Lateral Malleolus Height	1.1	1.5	1.5	2.0	0.9	1.4	NA	NA	1.3
Menton-Sellion Length	0.9	1.3	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	NA	0.4	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	NA	0.2	NA	0.2	0.2	0.2	0.3	0.2	0.2
Midshoulder Height, Sitting	0.6	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6
Midthigh Breadth	NA	1.2	1.5	2.8	3.0	1.6	NA	NA	2.6
Midthigh Circumference	NA	0.5	1.4	0.8	0.8	0.8	NA	NA	0.5
Midthigh Depth	NA	1.4	1.9	1.4	1.7	3.2	NA	NA	2.2
Midthigh Height	NA	0.1	0.6	0.6	0.3	0.3	NA	NA	0.7
Neck Breadth	NA	1.8	NA	NA	3.3	NA	1.7	1.7	2.1
Neck Circumference	0.9	0.6	NA	NA	0.8	NA	0.8	0.8	0.6
Neck Depth	NA	1.0	NA	NA	3.1	NA	2.6	3.0	1.1
Neck Height, Lateral	0.2	0.1	NA	0.2	0.2	0.2	0.1	0.3	0.2
Popliteal Height	0.6	0.1	0.9	1.9	0.8	1.8	NA	NA	0.5
Radiale-Stylion Length	1.1	1.0	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	0.5	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	1.9	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Comp.	NA	NA	NA	0.5	0.5	0.8	0.3	0.5	0.2
Shoulder Circumference, Uncomp.	0.5	0.7	NA	0.4	0.5	0.5	0.7	0.4	0.2
Sitting Height	0.3	0.3	0.3	0.3	0.4	0.3	NA	NA	0.5
Stature	0.2	0.2	NA	0.2	0.2	0.2	0.3	0.2	0.3
Thigh Breadth, Crotch	NA	2.2	1.9	3.5	1.2	1.8	NA	1.8	3.0

TABLE 5 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Thigh Circumference, Crotch	NA	0.6	0.9	0.9	0.5	NA	1.0	1.2	0.6
Thigh Clearance	0.9	0.9	1.1	1.5	1.0	NA	NA	1.1	0.9
Thigh Depth, Crotch	NA	1.5	1.7	2.0	2.4	2.5	NA	2.6	1.8
Trochanteric Height	0.2	0.3	0.3	0.4	0.4	0.3	NA	NA	0.5
Vertical Trunk Circ (ASCC)	0.7	0.4	0.6	0.6	0.6	0.4	0.6	0.5	0.3
Waist Breadth	0.7	1.0	1.4	1.2	0.8	0.7	1.2	0.9	1.1
Waist Circumference, Omphalion	0.5	0.4	1.2	0.9	0.4	0.6	0.4	0.4	0.2
Waist Depth	1.1	1.4	1.8	2.0	1.1	1.2	1.3	1.1	0.9
Waist Height, Omphalion	0.3	0.4	0.3	0.3	0.4	0.4	0.3	0.3	0.4
Weight	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wrist Breadth	NA	1.8	NA	5.7	4.4	NA	4.2	NA	2.7
Wrist Circumference	0.8	0.9	NA	1.4	0.8	NA	1.5	NA	0.9
Wrist Depth	NA	1.3	NA	3.8	6.8	NA	1.8	NA	2.4

TABLE 6

REPEATED MEASURES BY LAYER COMPARED TO ANSUR
MEAN ABSOLUTE DIFFERENCE AS A PERCENT OF MEAN SIZE
COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Acromial Height, Sitting	0.8	0.5	0.5	NA	NA	1.0	1.0	1.8
Acromion Height	0.2	0.2	0.2	NA	0.3	0.3	0.5	0.2
Acromion-Radiale Length	0.4	0.6	NA	NA	NA	NA	NA	NA
Ankle Breadth	NA	1.7	0.0	NA	NA	2.0	NA	0.7
Ankle Circumference	0.6	0.5	1.3	NA	NA	1.2	NA	0.9
Ankle Depth	NA	0.0	0.0	NA	NA	1.7	NA	1.3
Ankle Height	NA	0.8	0.8	NA	NA	1.2	NA	0.6
Axilla (Scye) Height	0.2	0.3	0.4	NA	NA	0.3	NA	0.3
Ball of Foot Circumference	0.8	0.4	0.4	NA	NA	NA	NA	NA
Ball of Foot Length	0.4	1.0	1.0	NA	NA	NA	NA	NA
Biacromial Breadth	0.9	0.8	1.0	NA	NA	1.0	0.8	0.7
Biceps Breadth, Flexed	NA	2.2	2.2	NA	NA	5.4	NA	3.2
Biceps Circumference, Flexed	0.7	0.6	1.2	NA	NA	1.7	NA	1.1
Biceps Depth, Flexed	NA	0.9	2.6	NA	NA	4.7	NA	2.5
Bideltoid Breadth, Compressed	NA	NA	0.9	NA	NA	1.1	NA	0.2
Bideltoid Breadth, Uncompressed	0.8	0.6	1.5	NA	NA	1.0	NA	0.4
Bimalleolar Breadth	0.9	1.4	0.0	NA	NA	1.1	NA	1.6
Bitragion (Ear Cup) Breadth	NA	0.7	NA	NA	NA	0.7	NA	0.4
Buttock Circumference, Comp	NA	NA	0.5	NA	NA	1.0	NA	0.7
Buttock Circumference, Uncomp	0.4	0.3	0.4	NA	NA	0.5	NA	0.9
Buttock Depth, Compressed	NA	NA	0.4	NA	NA	1.9	NA	1.4
Buttock Depth, Uncompressed	1.7	1.6	1.4	NA	NA	1.7	NA	1.7
Buttock Height	0.2	0.1	0.3	NA	NA	0.5	NA	0.5
Buttock-Knee Length	0.6	0.3	0.7	NA	0.8	0.8	0.5	0.5
Buttock-Popliteal Length	1.0	0.6	0.6	NA	1.0	2.1	2.5	0.7

TABLE 6 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Calf Breadth	NA	0.9	0.8	NA	NA	2.8	NA	1.1
Calf Circumference	0.4	0.3	0.3	NA	NA	2.4	NA	1.0
Calf Depth	NA	0.8	0.8	NA	NA	3.0	NA	1.9
Calf Height	0.3	0.0	0.6	NA	NA	1.6	NA	0.5
Chest Breadth	1.0	0.6	1.6	NA	2.3	1.9	1.4	2.4
Chest Circumference	0.7	0.9	0.8	0.4	0.4	0.6	0.6	0.6
Chest Depth	1.2	0.8	2.4	1.7	0.6	1.3	1.2	1.1
Chest Depth - Deltoid Pt, Comp.	NA	NA	1.7	2.2	1.4	1.1	1.4	1.0
Chest Depth - Deltoid Pt, Uncomp.	NA	0.9	1.7	1.4	1.4	1.4	1.0	1.3
Chest Height	0.3	0.5	0.2	0.5	0.2	0.4	0.5	0.3
Crotch Height	0.7	0.5	0.5	0.5	NA	1.0	NA	1.9
Deltoid Point Height	NA	0.3	0.4	NA	0.2	0.4	0.4	0.2
Ectoorbitale-Top of Head	NA	0.9	NA	0.9	NA	1.9	NA	3.8
Elbow Breadth	NA	1.0	NA	NA	NA	9.6	NA	2.9
Elbow Circumference	0.5	0.4	NA	NA	NA	0.7	NA	0.9
Elbow Depth	NA	1.4	NA	NA	NA	7.9	NA	4.4
Eye Height, Sitting	0.6	0.6	0.6	NA	NA	0.9	NA	0.4
Foot Breadth Horizontal	0.6	1.0	0.9	NA	NA	NA	NA	NA
Foot Length	0.2	0.4	0.4	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	2.2	NA	NA	NA	2.5	NA	3.6
Forearm Circumference, Flexed	0.9	1.0	NA	NA	NA	2.5	NA	2.3
Forearm Depth, Flexed	NA	2.1	NA	NA	NA	5.1	NA	1.6
Glabella-Helmet Rim	NA	NA	NA	NA	NA	12.0	NA	13.3
Hand Breadth	0.4	0.0	NA	NA	NA	1.1	NA	NA
Hand Circumference	0.4	1.5	NA	NA	NA	0.5	NA	NA
Hand Length	0.6	1.0	NA	NA	NA	2.5	NA	NA
Hand Thickness	NA	0.0	NA	NA	NA	8.1	NA	NA
Head (Helmet) Breadth	0.3	0.6	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	0.3	0.5	NA	NA	NA	NA	NA	NA
Head (Helmet) Circumference	0.1	0.2	NA	NA	NA	NA	NA	NA
Heel Breadth	1.5	1.4	1.3	NA	NA	1.1	NA	NA

TABLE 6 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	2.8	NA	2.9
Hip Breadth, Compressed	NA	NA	0.6	NA	NA	0.6	NA	0.8
Hip Breadth, Uncompressed	0.6	0.9	0.8	NA	NA	0.8	NA	1.0
Knee Breadth	NA	0.9	NA	NA	NA	4.6	NA	3.9
Knee Circumference	0.6	0.8	NA	NA	NA	1.7	NA	2.0
Knee Depth	NA	0.0	NA	NA	NA	2.6	NA	1.9
Knee Height, Midpatella	0.5	0.2	0.4	NA	NA	0.6	NA	0.6
Knee Height, Sitting	0.1	0.0	0.4	NA	NA	0.3	NA	0.7
Lateral Femoral Epicondyle Ht.	0.3	0.2	0.2	NA	NA	0.6	NA	0.4
Lateral Malleolus Height	1.1	1.4	1.4	NA	NA	0.8	NA	1.7
Menton-Sellion Length	0.9	0.8	NA	NA	NA	0.8	NA	NA
Menton-Top of Head	NA	0.4	NA	NA	NA	1.8	NA	0.6
Midshoulder Height	NA	0.2	0.3	NA	0.3	0.5	0.3	0.2
Midshoulder Height, Sitting	0.6	0.5	0.8	NA	0.3	0.3	0.5	0.3
Midthigh Breadth	NA	1.8	NA	NA	NA	0.5	NA	1.9
Midthigh Circumference	NA	0.4	NA	NA	NA	0.9	NA	1.2
Midthigh Depth	NA	1.1	NA	NA	NA	1.7	NA	1.6
Midthigh Height	NA	0.1	0.3	NA	NA	0.7	NA	0.5
Neck Breadth	NA	1.7	NA	2.0	NA	1.2	NA	2.7
Neck Circumference	0.9	0.5	NA	1.0	NA	0.9	NA	0.9
Neck Depth	NA	0.9	NA	0.9	NA	3.1	NA	3.4
Neck Height, Lateral	0.2	0.1	0.1	NA	0.1	0.1	0.3	0.3
Popliteal Height	0.6	0.2	0.2	NA	NA	0.7	NA	1.5
Radiale-Stylion Length	1.1	1.2	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	0.5	NA	NA	NA	1.7	NA	1.4
Sellion-Top of Head	NA	1.9	NA	NA	NA	3.4	NA	2.8
Shoulder Circumference, Comp.	NA	NA	0.5	0.5	0.7	0.8	0.3	0.3
Shoulder Circumference, Uncomp.	0.5	1.0	0.5	0.3	0.3	0.6	0.4	0.2
Sitting Height	0.3	0.3	0.3	NA	NA	0.6	NA	0.2
Stature	0.2	0.2	0.1	0.2	0.1	0.3	0.1	0.2
Thigh Breadth, Crotch	NA	2.7	NA	NA	NA	1.0	NA	1.4

TABLE 6 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Thigh Circumference, Crotch	NA	0.7	NA	NA	NA	0.7	NA	0.9
Thigh Clearance	0.9	0.6	NA	NA	NA	1.5	NA	1.4
Thigh Depth, Crotch	NA	1.6	NA	NA	NA	2.0	NA	1.2
Trochanteric Height	0.2	0.4	0.4	NA	NA	0.5	NA	0.4
Vertical Trunk Circ (ASCC)	0.7	0.5	0.6	1.0	0.4	1.0	0.5	0.4
Waist Breadth	0.7	1.3	1.5	1.5	0.6	0.8	1.3	0.8
Waist Circumference, Omphalion	0.5	0.5	1.1	0.8	0.8	0.3	0.7	0.2
Waist Depth	1.1	1.3	1.1	1.9	2.1	1.0	1.4	2.1
Waist Height, Omphalion	0.3	0.6	0.5	0.6	0.4	0.4	0.2	0.5
Weight	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Wrist Breadth	NA	1.6	NA	NA	NA	2.4	NA	1.0
Wrist Circumference	0.8	1.2	NA	NA	NA	3.8	NA	1.1
Wrist Depth	NA	0.0	NA	NA	NA	4.3	NA	2.6

TABLE 7

REPEATED MEASURES BY LAYER COMPARED TO ANSUR
MEAN ABSOLUTE DIFFERENCE AS A PERCENT OF MEAN SIZE
COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Acromial Height, Sitting	0.8	0.5	0.7	1.0	NA	0.8	0.7	0.5	NA	1.0
Acromion Height	0.2	0.2	NA	0.3	NA	0.3	0.3	0.1	0.1	0.3
Acromion-Radiale Length	0.4	0.6	NA	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	NA	1.7	2.8	4.9	NA	2.6	NA	NA	NA	3.2
Ankle Circumference	0.6	0.5	0.8	0.9	NA	1.7	NA	NA	NA	0.4
Ankle Depth	NA	0.0	2.2	5.7	NA	2.5	NA	NA	NA	2.9
Ankle Height	NA	0.8	0.8	0.8	NA	1.8	NA	NA	NA	1.2
Axilla (Scye) Height	0.2	0.3	NA	0.7	NA	0.6	NA	0.3	0.3	0.4
Ball of Foot Circumference	0.8	0.4	NA	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	0.4	1.0	NA	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	0.9	0.8	NA	1.1	NA	0.8	NA	0.2	0.2	0.9
Biceps Breadth, Flexed	NA	2.2	NA	2.9	NA	2.3	NA	0.7	NA	1.8
Biceps Circumference, Flexed	0.7	0.6	NA	1.6	NA	1.3	NA	1.5	NA	1.0
Biceps Depth, Flexed	NA	0.9	NA	5.5	NA	5.5	NA	3.8	NA	1.8
Bideltoid Breadth, Compressed	NA	NA	NA	1.5	NA	0.4	NA	0.8	0.8	0.6
Bideltoid Breadth, Uncomp.	0.8	0.6	NA	1.0	NA	1.4	NA	0.4	0.4	0.5
Bimalleolar Breadth	0.9	1.4	2.5	8.3	NA	6.8	2.7	NA	NA	1.3
Bitragion (Ear Cup) Breadth	NA	0.7	NA	NA	NA	NA	0.7	0.4	NA	NA
Buttock Circumference, Comp	NA	NA	0.5	0.5	NA	0.8	0.5	NA	NA	0.3
Buttock Circumference, Uncomp	0.4	0.3	0.7	0.3	NA	0.8	0.5	NA	NA	0.5
Buttock Depth, Compressed	NA	NA	2.7	1.8	NA	1.4	1.0	NA	NA	0.6
Buttock Depth, Uncompressed	1.7	1.6	2.6	3.1	NA	1.0	1.2	NA	NA	0.9
Buttock Height	0.2	0.1	0.2	0.6	NA	0.4	0.6	NA	NA	0.4
Buttock-Knee Length	0.6	0.3	0.7	1.0	NA	0.8	0.6	NA	NA	0.9
Buttock-Popliteal Length	1.0	0.6	1.1	1.6	NA	1.1	1.6	NA	NA	2.2

TABLE 7 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Calf Breadth	NA	0.9	0.8	3.6	NA	3.2	2.1	NA	NA	1.5
Calf Circumference	0.4	0.3	0.3	1.6	NA	1.2	0.5	NA	NA	0.8
Calf Depth	NA	0.8	0.8	4.3	NA	2.5	1.5	NA	NA	1.1
Calf Height	0.3	0.0	0.9	0.6	NA	0.5	0.3	NA	NA	0.3
Chest Breadth	1.0	0.6	NA	2.9	1.5	0.8	0.8	2.3	1.8	1.5
Chest Circumference	0.7	0.9	NA	0.9	0.9	0.9	0.8	0.8	0.7	0.6
Chest Depth	1.2	0.8	NA	2.4	1.0	1.3	1.3	1.5	2.6	1.3
Chest Depth - Deltoid Pt, Comp.	NA	NA	NA	2.2	1.6	1.9	1.5	1.1	1.0	1.6
Chest Depth - Deltoid Pt, Uncomp.	NA	0.9	NA	1.2	0.8	1.9	1.5	1.4	1.0	0.6
Chest Height	0.3	0.5	NA	0.4	0.4	0.2	0.4	0.4	0.5	0.5
Crotch Height	0.7	0.5	1.1	1.1	NA	0.8	0.8	NA	NA	1.4
Deltoid Point Height	NA	0.3	NA	0.1	0.4	0.4	0.3	0.3	0.2	0.2
Ectoorbitale-Top of Head	NA	0.9	NA	NA	NA	NA	NA	1.2	NA	NA
Elbow Breadth	NA	1.0	NA	6.3	NA	3.1	NA	2.3	NA	2.6
Elbow Circumference	0.5	0.4	NA	2.1	NA	2.5	NA	1.7	NA	1.1
Elbow Depth	NA	1.4	NA	5.6	NA	3.4	NA	2.6	NA	1.8
Eye Height, Sitting	0.6	0.6	0.5	0.4	NA	0.5	0.5	NA	NA	0.6
Foot Breadth Horizontal	0.6	1.0	NA	NA	NA	NA	NA	NA	NA	NA
Foot Length	0.2	0.4	NA	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	2.2	NA	4.6	NA	2.2	NA	3.7	NA	2.8
Forearm Circumference, Flexed	0.9	1.0	NA	2.8	NA	1.6	NA	1.0	NA	0.9
Forearm Depth, Flexed	NA	2.1	NA	5.4	NA	2.4	NA	0.7	NA	3.6
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA	4.3	NA	NA
Hand Breadth	0.4	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	0.4	1.5	NA	NA	NA	NA	NA	NA	NA	NA
Hand Length	0.6	1.0	NA	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	0.0	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	0.3	0.6	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	0.3	0.5	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Circumference	0.1	0.2	NA	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	1.5	1.4	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 7 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA	2.6	NA	NA
Hip Breadth, Compressed	NA	NA	1.1	0.6	NA	0.8	1.0	NA	NA	0.7
Hip Breadth, Uncompressed	0.6	0.9	1.1	1.1	NA	0.8	0.7	NA	NA	0.5
Knee Breadth	NA	0.9	0.8	2.9	NA	4.1	2.0	NA	NA	2.0
Knee Circumference	0.6	0.8	2.1	2.4	NA	1.2	0.9	NA	NA	0.6
Knee Depth	NA	0.0	2.2	4.9	NA	2.1	1.7	NA	NA	0.9
Knee Height, Midpatella	0.5	0.2	0.8	0.6	NA	1.0	0.8	NA	NA	0.8
Knee Height, Sitting	0.1	0.0	0.4	0.4	NA	0.5	0.8	NA	NA	0.5
Lateral Femoral Epicondyle Ht.	0.3	0.2	0.4	0.6	NA	0.4	0.4	NA	NA	0.4
Lateral Malleolus Height	1.1	1.4	1.3	2.7	NA	0.0	0.9	NA	NA	0.8
Menton-Sellion Length	0.9	0.8	NA	NA	NA	NA	NA	2.3	NA	NA
Menton-Top of Head	NA	0.4	NA	NA	NA	NA	NA	1.1	NA	NA
Midshoulder Height	NA	0.2	NA	NA	0.2	0.3	0.2	0.3	0.3	0.3
Midshoulder Height, Sitting	0.6	0.5	0.6	0.5	0.5	0.6	0.6	0.5	0.6	0.8
Midthigh Breadth	NA	1.8	1.2	4.0	NA	1.9	1.3	NA	NA	1.7
Midthigh Circumference	NA	0.4	2.0	0.8	NA	0.8	1.3	NA	NA	0.5
Midthigh Depth	NA	1.1	2.2	1.1	NA	2.0	2.6	NA	NA	1.8
Midthigh Height	NA	0.1	0.6	0.6	NA	0.5	0.5	NA	NA	0.8
Neck Breadth	NA	1.7	NA	NA	NA	1.3	NA	1.7	NA	2.6
Neck Circumference	0.9	0.5	NA	NA	NA	0.9	NA	0.8	NA	1.3
Neck Depth	NA	0.9	NA	NA	NA	2.2	NA	3.2	NA	1.7
Neck Height, Lateral	0.2	0.1	NA	0.2	0.3	0.1	0.2	0.2	0.3	0.3
Popliteal Height	0.6	0.2	1.0	2.7	NA	1.5	1.9	NA	NA	0.8
Radiale-Stylion Length	1.1	1.2	NA	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	0.5	NA	NA	NA	NA	NA	0.8	NA	NA
Sellion-Top of Head	NA	1.9	NA	NA	NA	NA	NA	1.3	NA	NA
Shoulder Circumference, Comp.	NA	NA	NA	0.4	0.3	0.5	0.4	0.4	0.2	0.4
Shoulder Circumference, Uncomp.	0.5	1.0	NA	0.4	0.3	0.6	0.4	0.7	0.7	0.5
Sitting Height	0.3	0.3	0.3	0.4	NA	0.2	0.4	0.4	NA	0.4
Stature	0.2	0.2	NA	0.3	0.2	0.2	0.2	0.2	0.2	0.3
Thigh Breadth, Crotch	NA	2.7	2.7	4.4	NA	1.9	1.8	NA	NA	1.7

TABLE 7 (continued)

	ANSUR	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Thigh Circumference, Crotch	NA	0.7	1.3	0.8	NA	1.0	0.9	NA	NA	0.4
Thigh Clearance	0.9	0.6	1.1	1.9	NA	1.0	2.2	NA	2.2	1.3
Thigh Depth, Crotch	NA	1.6	2.5	2.5	NA	2.0	2.2	NA	NA	2.2
Trochanteric Height	0.2	0.4	0.3	0.4	NA	0.4	0.5	NA	NA	0.2
Vertical Trunk Circ (ASCC)	0.7	0.5	0.8	0.8	0.9	0.6	0.5	0.4	0.4	0.3
Waist Breadth	0.7	1.3	1.5	1.4	0.5	0.8	1.0	0.7	1.7	0.5
Waist Circumference, Omphalion	0.5	0.5	1.1	1.2	0.5	0.5	0.4	0.3	0.6	0.4
Waist Depth	1.1	1.3	1.1	2.1	1.0	1.5	1.2	2.0	1.4	1.0
Waist Height, Omphalion	0.3	0.6	0.6	0.3	0.4	0.5	0.4	0.4	0.3	0.4
Weight	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Wrist Breadth	NA	1.6	NA	5.9	NA	3.4	NA	2.6	NA	1.1
Wrist Circumference	0.8	1.2	NA	1.4	NA	1.9	NA	1.4	NA	0.7
Wrist Depth	NA	0.0	NA	4.3	NA	1.3	NA	3.3	NA	3.8

CHAPTER 4

MEASUREMENT REPLICATIONS:DRESS VS. REDRESS

Redress measurements were made to assess the effect of dressing on measurement variation. Dress/redress variability arises from the different ways a piece of clothing can be donned, and the different ways clothing settles on the body as a result. Tables F-1 through F-8 in Appendix F show the dress/redress MADs by clothing layer for each of the five clothing ensembles for males and females separately. The MADs expressed as a percentage of dimension size are shown in Tables 8 through 12. Both sets of measurements were made immediately after the subjects were dressed (or redressed) and landmarked.

Mean average delta values were substantially larger in most cases, for the dress/redress comparisons than they were for the initial and repeat measurement comparisons. As with the initial and repeat comparisons, the dress/redress comparisons have the poorest repeatability for depths, breadths, and circumferences of the arms and legs. The heights, with few exceptions, had good repeatability, indicating that dressing and redressing did not affect posture.

The data indicate that the manner in which subjects dress themselves varies from one time to the next, and that this variation affects the anthropometry, although these conclusions are tenuous, at best, because of the very small sample, and because too many factors other than redressing (e.g. subject fatigue and subject marking) can affect the results. Furthermore, the subjects used in this study were not experienced wearers of military clothing and they were usually assisted in dressing by measuring team members. It is conceivable that an experienced wearer of military clothing would adjust the clothing more consistently. It should also be remembered that some clothing items fit poorly on some subjects; it is probable that better fitting clothing would have shown more repeatable results in dress/redress trials.

TABLE 8

REDRESS REPEATED MEASURE
MAD AS A PERCENT OF MEAN SIZE
GROUND SOLDIER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	1.0	0.5	1.0	0.7
Acromion Height	0.4	0.5	0.6	0.1
Acromion-Radiale Length	NA	NA	NA	NA
Ankle Breadth	1.8	5.0	8.0	NA
Ankle Circumference	1.4	3.1	0.9	NA
Ankle Depth	2.6	4.9	4.0	NA
Ankle Height	2.8	2.1	4.7	NA
Axilla (Scye) Height	0.8	0.7	0.3	0.8
Ball of Foot Circumference	0.4	0.3	0.6	NA
Ball of Foot Length	1.7	0.5	1.0	NA
Biacromial Breadth	2.3	2.0	3.0	1.5
Biceps Breadth, Flexed	3.9	6.7	7.4	NA
Biceps Circumference, Flexed	1.4	2.0	1.9	NA
Biceps Depth, Flexed	3.1	2.5	8.8	NA
Bideltoid Breadth, Compressed	0.7	1.5	2.3	0.9
Bideltoid Breadth, Uncompressed	1.2	1.2	0.8	1.0
Bimalleolar Breadth	3.0	1.2	4.6	NA
Bitragion (Ear Cup) Breadth	NA	0.0	NA	NA
Buttock Circumference, Compressed	0.9	0.9	0.7	NA
Buttock Circumference, Uncompressed	0.7	0.7	0.8	NA
Buttock Depth, Compressed	2.4	1.8	2.4	NA
Buttock Depth, Uncompressed	3.8	4.7	2.9	NA
Buttock Height	0.2	0.2	0.1	NA
Buttock-Knee Length	0.7	1.9	1.8	1.1
Buttock-Popliteal Length	1.7	2.5	1.6	1.5
Calf Breadth	0.9	7.3	3.1	NA
Calf Circumference	0.3	1.3	4.1	NA
Calf Depth	0.0	12.6	4.4	NA
Calf Height	0.9	0.8	0.3	NA
Chest Breadth	1.7	5.9	2.9	2.8
Chest Circumference	0.8	2.7	0.8	0.7
Chest Depth	2.2	1.6	5.9	2.6
Chest Depth - Deltoid Point, Comp	3.7	2.0	3.1	0.7
Chest Depth - Deltoid Point, Uncomp	0.5	4.6	1.7	3.2
Chest Height	0.3	0.4	0.3	0.2
Crotch Height	1.5	1.3	1.8	NA
Deltoid Point Height	0.7	0.3	0.7	0.4
Ectoorbitale-Top of Head	NA	3.5	3.8	NA
Elbow Breadth	NA	8.4	9.6	NA
Elbow Circumference	NA	2.6	4.4	NA
Elbow Depth	NA	7.4	6.0	NA

TABLE 8 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Eye Height, Sitting	0.3	0.5	0.7	NA
Foot Breadth Horizontal	3.2	1.0	0.8	NA
Foot Length	0.8	0.0	0.6	NA
Forearm Breadth, Flexed	NA	5.1	4.4	NA
Forearm Circumference, Flexed	NA	2.8	1.5	NA
Forearm Depth, Flexed	NA	5.4	9.8	NA
Glabella-Helmet Rim	NA	2.4	NA	NA
Hand Breadth	NA	NA	4.8	NA
Hand Circumference	NA	NA	1.5	NA
Hand Length	NA	NA	6.6	NA
Hand Thickness	NA	NA	14.6	NA
Head (Helmet) Breadth	NA	0.0	NA	NA
Head (Helmet) Length	NA	0.0	NA	NA
Head (Helmet)Circumference	NA	0.0	NA	NA
Heel Breadth	2.9	0.0	2.1	NA
Helmet Rim-Top of Head	NA	4.6	5.1	NA
Hip Breadth, Compressed	0.9	1.1	2.1	NA
Hip Breadth, Uncompressed	1.7	3.6	2.5	NA
Knee Breadth	NA	4.7	12.9	NA
Knee Circumference	NA	4.0	4.0	NA
Knee Depth	NA	8.1	9.0	NA
Knee Height, Midpatella	0.7	0.4	0.2	NA
Knee Height, Sitting	0.6	0.6	0.9	NA
Lateral Femoral Epicondyle Height	0.4	0.6	0.2	NA
Lateral Malleolus Height	3.1	2.9	1.9	NA
Menton-Sellion Length	NA	1.8	1.2	NA
Menton-Top of Head	NA	2.4	2.0	NA
Midshoulder Height	0.1	0.2	0.8	0.6
Midshoulder Height, Sitting	0.3	0.8	0.7	1.1
Midthigh Breadth	NA	4.7	3.0	NA
Midthigh Circumference	NA	0.5	2.9	NA
Midthigh Depth	NA	6.1	5.5	NA
Midthigh Height	0.3	0.4	0.1	NA
Neck Breadth	NA	2.4	3.7	7.8
Neck Circumference	NA	1.3	3.4	4.3
Neck Depth	NA	3.9	1.2	6.4
Neck Height, Lateral	0.1	0.3	0.5	0.3
Popliteal Height	0.8	3.1	5.2	NA
Radiale-Stylion Length	NA	NA	NA	NA
Sellion-Back of Head	NA	0.9	0.8	NA
Sellion-Top of Head	NA	3.0	4.3	NA
Shoulder Circumference, Compressed	0.7	1.4	1.4	0.5
Shoulder Circumference, Uncompressec	0.6	1.3	0.7	0.6
Sitting Height	0.1	0.2	0.3	NA
Stature	0.2	0.1	0.2	0.3
Thigh Breadth, Crotch	NA	2.5	1.9	NA
Thigh Circumference, Crotch	NA	1.1	1.7	NA
Thigh Clearance	NA	2.7	1.5	NA
Thigh Depth, Crotch	NA	1.7	3.4	NA

TABLE 8 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Trochanteric Height	0.3	0.5	0.3	NA
Vertical Trunk Circumference (ASCC)	0.7	0.7	1.1	0.9
Waist Breadth	1.3	1.8	3.5	2.1
Waist Circumference, Omphalion	1.0	1.7	1.9	0.9
Waist Depth	5.8	4.0	3.7	1.9
Waist Height, Omphalion	0.2	0.6	0.5	0.7
Weight	0.2	0.1	0.1	0.1
Wrist Breadth	NA	2.7	5.7	NA
Wrist Circumference	NA	2.0	3.5	NA
Wrist Depth	NA	5.0	3.9	NA

TABLE 9

REDRESS REPEATED MEASURE
MAD AS A PERCENT OF MEAN SIZE
AVIATOR WARM WEATHER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	1.0	0.9	0.5	0.8	1.0
Acromion Height	0.4	0.5	0.2	0.5	0.7
Acromion-Radiale Length	NA	NA	NA	NA	NA
Ankle Breadth	1.8	3.8	NA	NA	8.1
Ankle Circumference	1.4	1.6	NA	NA	2.4
Ankle Depth	2.6	10.9	NA	NA	5.5
Ankle Height	2.8	4.1	NA	NA	2.6
Axilla (Scye) Height	0.8	0.6	0.8	0.6	0.5
Ball of Foot Circumference	0.4	NA	NA	NA	NA
Ball of Foot Length	1.7	NA	NA	NA	NA
Biacromial Breadth	2.3	3.6	3.7	5.5	6.6
Biceps Breadth, Flexed	3.9	6.8	10.5	NA	4.3
Biceps Circumference, Flexed	1.4	4.8	2.8	NA	3.5
Biceps Depth, Flexed	3.1	5.5	4.6	NA	3.5
Bideltoid Breadth, Compressed	0.7	1.5	1.0	NA	2.9
Bideltoid Breadth, Uncompressed	1.2	1.6	2.2	NA	2.0
Bimalleolar Breadth	3.0	3.3	NA	NA	2.3
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	0.9	0.6	NA	1.4	0.9
Buttock Circumference, Uncompressed	0.7	1.0	NA	1.5	0.7
Buttock Depth, Compressed	2.4	1.6	NA	2.3	3.1
Buttock Depth, Uncompressed	3.8	1.5	NA	1.8	3.1
Buttock Height	0.2	0.2	NA	0.3	0.2
Buttock-Knee Length	0.7	1.0	0.9	NA	1.5
Buttock-Popliteal Length	1.7	3.1	4.0	NA	3.9
Calf Breadth	0.9	9.0	NA	NA	5.3
Calf Circumference	0.3	1.9	NA	NA	5.9
Calf Depth	0.0	9.0	NA	NA	8.9
Calf Height	0.9	0.3	NA	NA	0.8
Chest Breadth	1.7	3.2	4.8	2.5	2.5
Chest Circumference	0.8	2.1	1.5	2.0	1.0
Chest Depth	2.2	2.1	4.6	3.9	3.5
Chest Depth - Deltoid Point, Comp	3.7	2.6	4.4	2.1	7.1
Chest Depth - Deltoid Point, Uncomp	0.5	4.5	3.2	2.1	6.1
Chest Height	0.3	0.2	0.2	0.3	0.5
Crotch Height	1.5	0.8	NA	1.3	2.7
Deltoid Point Height	0.7	0.5	0.4	0.8	0.9
Ectoorbitale-Top of Head	NA	3.1	NA	NA	2.9
Elbow Breadth	NA	6.7	10.4	NA	3.9
Elbow Circumference	NA	1.3	4.9	NA	4.7
Elbow Depth	NA	14.3	11.0	NA	4.6

TABLE 9 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Eye Height, Sitting	0.3	0.5	NA	NA	0.8
Foot Breadth Horizontal	3.2	NA	NA	NA	NA
Foot Length	0.8	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	11.1	3.4	NA	4.2
Forearm Circumference, Flexed	NA	1.6	2.3	NA	4.3
Forearm Depth, Flexed	NA	3.8	6.8	NA	3.1
Glabella-Helmet Rim	NA	5.9	NA	NA	85.7
Hand Breadth	NA	3.6	NA	NA	NA
Hand Circumference	NA	1.6	NA	NA	NA
Hand Length	NA	2.0	NA	NA	NA
Hand Thickness	NA	3.2	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA
Heel Breadth	2.9	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	4.6	NA	NA	1.6
Hip Breadth, Compressed	0.9	0.6	NA	NA	1.3
Hip Breadth, Uncompressed	1.7	1.4	NA	NA	1.8
Knee Breadth	NA	6.3	NA	NA	8.3
Knee Circumference	NA	3.5	NA	NA	3.3
Knee Depth	NA	4.2	NA	NA	3.3
Knee Height, Midpatella	0.7	0.2	NA	NA	0.8
Knee Height, Sitting	0.6	0.4	NA	NA	0.4
Lateral Femoral Epicondyle Height	0.4	0.4	NA	NA	0.4
Lateral Malleolus Height	3.1	6.3	NA	NA	1.9
Menton-Sellion Length	NA	NA	NA	NA	1.8
Menton-Top of Head	NA	1.1	NA	NA	1.2
Midshoulder Height	0.1	0.2	0.4	0.4	0.4
Midshoulder Height, Sitting	0.3	0.5	0.7	0.7	0.8
Midthigh Breadth	NA	2.2	NA	NA	2.5
Midthigh Circumference	NA	0.5	NA	NA	1.7
Midthigh Depth	NA	5.6	NA	NA	3.3
Midthigh Height	0.3	0.1	NA	NA	0.4
Neck Breadth	NA	6.5	3.4	NA	5.5
Neck Circumference	NA	3.9	8.5	NA	6.5
Neck Depth	NA	1.8	4.4	NA	10.0
Neck Height, Lateral	0.1	0.2	0.1	0.3	0.3
Popliteal Height	0.8	2.1	NA	NA	3.3
Radiale-Stylion Length	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	3.2	NA	NA	2.3
Shoulder Circumference, Compressed	0.7	1.0	1.0	1.4	4.3
Shoulder Circumference, Uncompressec	0.6	1.1	0.5	1.7	3.9
Sitting Height	0.1	0.4	NA	NA	0.3
Stature	0.2	0.2	0.1	0.2	0.3
Thigh Breadth, Crotch	NA	2.6	NA	NA	1.5
Thigh Circumference, Crotch	NA	1.3	1.3	1.9	0.9
Thigh Clearance	NA	3.4	NA	NA	4.0
Thigh Depth, Crotch	NA	3.5	NA	5.0	4.0

TABLE 9 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Trochanteric Height	0.3	0.3	NA	NA	0.2
Vertical Trunk Circumference (ASCC)	0.7	0.8	0.4	0.6	0.9
Waist Breadth	1.3	3.7	3.2	3.3	4.4
Waist Circumference, Omphalion	1.0	1.1	2.0	1.9	0.7
Waist Depth	5.8	3.9	4.1	4.5	3.7
Waist Height, Omphalion	0.2	0.3	0.3	0.2	0.4
Weight	0.2	0.3	0.1	0.1	0.1
Wrist Breadth	NA	4.2	4.5	NA	5.6
Wrist Circumference	NA	1.0	1.1	NA	3.7
Wrist Depth	NA	7.0	3.9	NA	1.2

TABLE 10

REDRESS REPEATED MEASURE
MAD AS A PERCENT OF MEAN SIZE
AVIATOR COLD WEATHER ENSEMBLE
SEXES COMBINED
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	0.5	1.2	1.8	0.3	0.8	NA	1.0
Acromion Height	0.4	NA	0.5	0.6	0.3	0.4	0.4
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	4.4	6.9	11.6	8.5	NA	NA	2.6
Ankle Circumference	2.5	4.6	5.0	2.4	NA	NA	1.0
Ankle Depth	5.9	6.0	7.2	7.0	NA	NA	4.8
Ankle Height	3.4	10.1	4.5	3.3	NA	NA	1.8
Axilla (Scye) Height	NA	0.6	0.7	0.7	1.0	0.6	0.6
Ball of Foot Circumference	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	NA	5.0	3.5	NA	1.0	1.5	3.3
Biceps Breadth, Flexed	NA	10.4	6.3	NA	6.4	NA	4.1
Biceps Circumference, Flexed	NA	1.7	1.9	NA	2.6	NA	1.6
Biceps Depth, Flexed	NA	5.8	6.6	NA	4.7	NA	2.5
Bideltoid Breadth, Compressed	NA	1.8	0.9	NA	1.3	NA	1.6
Bideltoid Breadth, Uncompressed	NA	1.7	0.8	NA	1.0	NA	0.9
Bimalleolar Breadth	4.1	8.4	9.0	3.5	NA	NA	5.4
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	0.2	0.8	0.8	0.4	NA	0.9	0.6
Buttock Circumference, Uncompressed	0.4	0.7	0.5	0.7	NA	1.1	2.1
Buttock Depth, Compressed	2.3	2.6	2.5	1.0	NA	2.0	1.8
Buttock Depth, Uncompressed	5.9	1.3	1.0	0.6	NA	2.2	2.2
Buttock Height	0.2	0.3	0.2	0.3	NA	0.6	0.2
Buttock-Knee Length	0.7	1.3	1.5	0.8	1.6	1.6	2.3
Buttock-Popliteal Length	1.5	3.4	1.9	1.6	3.8	3.7	1.6
Calf Breadth	0.8	3.7	3.2	4.5	NA	NA	2.5
Calf Circumference	1.1	3.5	2.3	1.1	NA	NA	1.5
Calf Depth	2.6	5.2	6.0	3.6	NA	NA	6.1
Calf Height	1.2	0.6	0.5	1.6	NA	NA	0.5

TABLE 10 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Eye Height, Sitting	1.3	0.8	0.8	0.6	NA	NA	0.5
Foot Breadth Horizontal	NA	NA	NA	NA	NA	NA	NA
Foot Length	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	8.3	1.6	NA	3.8	NA	2.7
Forearm Circumference, Flexed	NA	1.5	2.0	NA	2.2	NA	1.1
Forearm Depth, Flexed	NA	4.2	5.4	NA	3.9	NA	4.3
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	NA	NA	NA	NA	NA	NA	NA
Hand Length	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	0.9	0.6	0.8	0.8	NA	NA	1.0
Hip Breadth, Uncompressed	1.7	1.6	0.8	1.2	NA	NA	3.0
Knee Breadth	6.6	1.7	4.6	3.7	NA	NA	6.5
Knee Circumference	2.1	2.7	2.1	2.3	NA	NA	2.0
Knee Depth	3.9	6.4	5.3	3.2	NA	NA	5.9
Knee Height, Midpatella	0.2	0.4	0.4	0.6	NA	NA	0.6
Knee Height, Sitting	0.4	0.9	0.4	0.4	NA	NA	0.9
Lateral Femoral Epicondyle Height	0.4	0.8	0.4	0.4	NA	NA	0.4
Lateral Malleolus Height	5.8	6.8	2.7	3.7	NA	NA	4.2
Menton-Sellion Length	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	NA	0.5	0.4	0.3	0.6	0.6	0.4
Midshoulder Height, Sitting	0.8	0.5	1.1	0.8	0.6	0.9	1.1
Midthigh Breadth	1.8	2.6	2.5	3.2	NA	NA	3.9
Midthigh Circumference	1.3	1.2	1.0	1.4	NA	NA	0.8
Midthigh Depth	2.7	4.4	3.5	2.4	NA	NA	6.2
Midthigh Height	0.3	0.6	0.3	0.3	NA	NA	0.4
Neck Breadth	NA	NA	7.3	NA	5.7	7.4	1.5
Neck Circumference	NA	NA	2.5	NA	2.9	3.3	3.5

TABLE 10 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Neck Depth	NA	NA	4.6	NA	3.9	7.9	9.2
Neck Height, Lateral	NA	0.3	0.3	0.4	0.3	0.1	0.3
Popliteal Height	2.9	2.9	3.4	1.6	NA	NA	2.7
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Compressed	NA	2.1	0.7	0.8	0.8	0.6	1.2
Shoulder Circumference, Uncompressec	NA	1.8	0.8	0.5	0.6	0.7	1.2
Sitting Height	0.6	0.4	0.6	0.2	NA	NA	0.5
Stature	NA	0.2	0.2	0.3	0.2	0.2	0.4
Thigh Breadth, Crotch	2.1	3.5	3.8	2.7	NA	3.1	4.3
Thigh Circumference, Crotch	0.7	1.3	2.4	NA	1.7	1.4	0.4
Thigh Clearance	1.7	4.5	1.5	NA	NA	1.4	1.7
Thigh Depth, Crotch	2.9	3.7	4.3	3.8	NA	4.4	6.4
Trochanteric Height	0.2	0.1	0.3	0.3	NA	NA	0.2
Vertical Trunk Circumference (ASCC)	0.7	0.4	0.8	0.7	0.6	0.4	1.6
Waist Breadth	1.9	2.7	1.2	0.8	3.8	1.5	1.7
Waist Circumference, Omphalion	2.0	0.9	1.1	0.4	1.3	0.5	0.8
Waist Depth	3.5	2.6	3.3	2.1	2.6	2.2	0.5
Waist Height, Omphalion	0.4	0.3	0.6	0.9	0.4	0.4	0.5
Weight	0.4	0.1	0.3	0.1	0.1	0.1	0.1
Wrist Breadth	NA	13.3	2.5	NA	7.0	NA	4.3
Wrist Circumference	NA	9.3	3.8	NA	2.5	NA	2.9
Wrist Depth	NA	7.5	8.2	NA	5.3	NA	10.8

TABLE 11

REDRESS REPEATED MEASURE
MAD AS A PERCENT OF MEAN SIZE
COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Acromial Height, Sitting	0.8	NA	NA	3.2	1.3	2.4
Acromion Height	0.4	NA	0.3	0.7	0.3	0.8
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA
Ankle Breadth	1.5	NA	NA	0.0	NA	3.5
Ankle Circumference	1.3	NA	NA	0.9	NA	1.3
Ankle Depth	2.4	NA	NA	1.7	NA	3.9
Ankle Height	3.3	NA	NA	2.9	NA	3.0
Axilla (Scye) Height	1.4	NA	NA	0.6	NA	0.8
Ball of Foot Circumference	0.8	NA	NA	NA	NA	NA
Ball of Foot Length	1.0	NA	NA	NA	NA	NA
Biacromial Breadth	2.8	NA	NA	8.3	7.2	9.1
Biceps Breadth, Flexed	3.3	NA	NA	3.6	NA	4.5
Biceps Circumference, Flexed	1.8	NA	NA	1.2	NA	2.6
Biceps Depth, Flexed	1.7	NA	NA	2.7	NA	2.5
Bideltoid Breadth, Compressed	0.2	NA	NA	2.0	NA	1.2
Bideltoid Breadth, Uncompressed	1.5	NA	NA	1.4	NA	1.0
Bimalleolar Breadth	3.9	NA	NA	2.2	NA	8.5
Bitragion (Ear Cup) Breadth	NA	NA	NA	1.5	NA	0.4
Buttock Circumference, Compressed	1.2	NA	NA	0.9	NA	0.7
Buttock Circumference, Uncompressed	0.9	NA	NA	0.8	NA	1.1
Buttock Depth, Compressed	1.2	NA	NA	2.6	NA	1.0
Buttock Depth, Uncompressed	5.4	NA	NA	3.0	NA	1.1
Buttock Height	0.2	NA	NA	0.3	NA	0.3
Buttock-Knee Length	1.2	NA	0.8	2.0	3.5	2.9
Buttock-Popliteal Length	1.2	NA	1.0	1.6	4.3	2.0
Calf Breadth	0.8	NA	NA	11.2	NA	5.1
Calf Circumference	0.3	NA	NA	1.9	NA	1.2
Calf Depth	0.0	NA	NA	3.6	NA	9.6
Calf Height	0.6	NA	NA	0.3	NA	0.5

TABLE 11 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Chest Breadth	1.9	NA	1.2	2.9	0.5	0.8
Chest Circumference	1.0	0.9	1.2	1.0	2.2	1.1
Chest Depth	2.4	2.7	0.6	1.6	2.5	1.6
Chest Depth - Deltoid Point, Comp	3.5	1.8	2.1	3.5	1.4	3.2
Chest Depth - Deltoid Point, Uncomp	0.4	1.4	1.4	4.5	0.3	4.7
Chest Height	0.3	0.3	0.4	0.6	0.4	0.3
Crotch Height	1.4	NA	NA	0.5	NA	2.8
Deltoid Point Height	0.5	0.3	0.4	1.1	0.6	0.9
Ectoorbitale-Top of Head	NA	NA	NA	1.9	NA	2.5
Elbow Breadth	NA	NA	NA	7.9	NA	3.7
Elbow Circumference	NA	NA	NA	0.7	NA	2.8
Elbow Depth	NA	NA	NA	7.9	NA	12.5
Eye Height, Sitting	0.5	NA	NA	0.6	NA	0.8
Foot Breadth Horizontal	1.9	NA	NA	NA	NA	NA
Foot Length	1.1	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	NA	NA	8.3	NA	1.4
Forearm Circumference, Flexed	NA	NA	NA	1.6	NA	3.0
Forearm Depth, Flexed	NA	NA	NA	12.0	NA	4.8
Glabella-Helmet Rim	NA	NA	NA	12.0	NA	20.0
Hand Breadth	NA	NA	NA	1.1	NA	NA
Hand Circumference	NA	NA	NA	1.4	NA	NA
Hand Length	NA	NA	NA	2.5	NA	NA
Hand Thickness	NA	NA	NA	5.4	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA
Heel Breadth	4.0	NA	NA	4.3	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	5.7	NA	8.7
Hip Breadth, Compressed	1.2	NA	NA	1.1	NA	1.6
Hip Breadth, Uncompressed	2.2	NA	NA	0.5	NA	2.7
Knee Breadth	NA	NA	NA	4.6	NA	6.1
Knee Circumference	NA	NA	NA	3.3	NA	3.1
Knee Depth	NA	NA	NA	6.2	NA	6.3
Knee Height, Midpatella	0.6	NA	NA	0.2	NA	0.4
Knee Height, Sitting	0.7	NA	NA	0.5	NA	0.8
Lateral Femoral Epicondyle Height	0.4	NA	NA	0.2	NA	0.0

TABLE 11 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Lateral Malleolus Height	2.9	NA	NA	5.0	NA	2.6
Menton-Sellion Length	NA	NA	NA	0.0	NA	NA
Menton-Top of Head	NA	NA	NA	1.1	NA	2.9
Midshoulder Height	0.2	NA	0.1	0.7	0.3	0.6
Midshoulder Height, Sitting	0.3	NA	0.3	2.2	0.9	1.4
Midthigh Breadth	NA	NA	NA	1.6	NA	2.4
Midthigh Circumference	NA	NA	NA	1.2	NA	4.3
Midthigh Depth	NA	NA	NA	8.1	NA	5.7
Midthigh Height	0.4	NA	NA	0.1	NA	0.1
Neck Breadth	NA	4.1	NA	1.9	NA	5.4
Neck Circumference	NA	2.0	NA	5.5	NA	5.3
Neck Depth	NA	0.0	NA	0.8	NA	1.1
Neck Height, Lateral	0.1	NA	0.2	0.5	0.5	0.2
Popliteal Height	0.7	NA	NA	2.7	NA	3.5
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	2.1	NA	1.4
Sellion-Top of Head	NA	NA	NA	2.0	NA	3.4
Shoulder Circumference, Compressed	0.8	0.6	1.0	2.5	1.7	1.2
Shoulder Circumference, Uncompressec	0.6	0.3	1.0	2.7	1.4	1.1
Sitting Height	0.1	NA	NA	0.8	NA	0.2
Stature	0.1	0.1	0.1	0.2	0.2	0.3
Thigh Breadth, Crotch	NA	NA	NA	1.5	NA	3.3
Thigh Circumference, Crotch	NA	NA	NA	1.3	NA	2.0
Thigh Clearance	NA	NA	NA	1.5	NA	1.0
Thigh Depth, Crotch	NA	NA	NA	5.2	NA	5.6
Trochanteric Height	0.4	NA	NA	0.3	NA	0.1
Vertical Trunk Circumference (ASCC)	1.1	1.3	1.0	0.9	1.2	1.2
Waist Breadth	0.3	0.3	1.4	1.1	0.5	1.0
Waist Circumference, Omphalion	1.5	1.3	1.7	1.1	1.1	0.2
Waist Depth	4.7	5.3	2.7	1.0	2.3	2.4
Waist Height, Omphalion	0.3	0.1	0.1	0.3	0.2	0.2
Weight	0.4	0.1	0.1	0.0	0.7	0.8
Wrist Breadth	NA	NA	NA	3.6	NA	4.0
Wrist Circumference	NA	NA	NA	1.7	NA	3.2
Wrist Depth	NA	NA	NA	1.4	NA	3.8

TABLE 12

REDRESS REPEATED MEASURE
MAD AS A PERCENT OF MEAN SIZE
COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Acromial Height, Sitting	0.5	1.0	NA	1.3	1.3	1.5	NA	1.6
Acromion Height	NA	0.3	0.2	0.7	0.8	1.0	1.0	0.3
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	5.6	9.1	NA	21.7	3.6	NA	NA	3.8
Ankle Circumference	3.7	3.4	NA	4.3	2.8	NA	NA	1.4
Ankle Depth	5.6	3.8	NA	15.7	0.6	NA	NA	4.7
Ankle Height	3.9	8.2	NA	3.0	6.9	NA	NA	3.5
Axilla (Scye) Height	NA	0.6	NA	0.6	NA	0.3	0.3	0.2
Ball of Foot Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	NA	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	NA	2.4	NA	3.6	NA	1.5	1.5	3.7
Biceps Breadth, Flexed	NA	9.4	NA	5.4	NA	1.4	NA	2.9
Biceps Circumference, Flexed	NA	1.1	NA	2.4	NA	0.0	NA	1.2
Biceps Depth, Flexed	NA	1.4	NA	3.4	NA	2.5	NA	3.0
Bideltoid Breadth, Compressed	NA	0.4	NA	1.3	NA	1.4	1.4	2.1
Bideltoid Breadth, Uncompressed	NA	0.6	NA	2.4	NA	1.0	1.0	1.3
Bimalleolar Breadth	3.8	10.4	NA	3.4	4.0	NA	NA	4.0
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	1.5	0.7	NA	NA
Buttock Circumference, Compressed	0.1	1.2	NA	0.3	2.1	NA	NA	1.9
Buttock Circumference, Uncompressed	0.6	1.2	NA	0.3	1.6	NA	NA	2.0
Buttock Depth, Compressed	3.1	2.9	NA	1.4	3.2	NA	NA	1.8
Buttock Depth, Uncompressed	9.2	0.6	NA	1.0	1.8	NA	NA	3.4
Buttock Height	0.1	0.3	NA	0.3	0.1	NA	NA	0.3
Buttock-Knee Length	0.8	0.8	NA	0.8	1.3	NA	NA	1.1
Buttock-Popliteal Length	1.1	3.4	NA	2.9	3.4	NA	NA	2.0
Calf Breadth	0.8	4.8	NA	4.4	4.1	NA	NA	7.0
Calf Circumference	1.3	4.0	NA	2.7	1.2	NA	NA	2.7
Calf Depth	2.4	4.9	NA	4.9	2.1	NA	NA	3.3
Calf Height	1.5	0.3	NA	1.1	1.1	NA	NA	0.5

TABLE 12 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Chest Breadth	NA	2.9	3.8	2.4	2.4	1.0	1.6	2.3
Chest Circumference	NA	1.8	0.6	0.6	1.0	1.2	0.6	1.0
Chest Depth	NA	2.1	0.7	1.7	1.0	3.0	2.9	2.6
Chest Depth - Deltoid Point, Comp	NA	3.5	2.8	1.9	3.4	3.3	3.4	2.2
Chest Depth - Deltoid Point, Uncomp	NA	1.2	2.7	2.6	2.6	3.4	2.9	1.2
Chest Height	NA	0.6	0.5	0.2	0.7	0.5	0.4	0.5
Crotch Height	1.2	1.2	NA	1.9	0.7	NA	NA	0.9
Deltoid Point Height	NA	0.4	0.2	0.8	0.9	1.3	0.8	0.3
Ectoorbitale-Top of Head	NA	NA	NA	NA	NA	2.5	NA	NA
Elbow Breadth	NA	15.0	NA	6.3	NA	2.3	NA	5.3
Elbow Circumference	NA	3.0	NA	4.7	NA	2.4	NA	1.7
Elbow Depth	NA	7.0	NA	6.2	NA	3.2	NA	3.6
Eye Height, Sitting	1.4	0.6	NA	0.1	0.9	NA	NA	0.2
Foot Breadth Horizontal	NA	NA	NA	NA	NA	NA	NA	NA
Foot Length	NA	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	9.9	NA	5.1	NA	3.7	NA	4.9
Forearm Circumference, Flexed	NA	2.0	NA	4.0	NA	2.0	NA	1.8
Forearm Depth, Flexed	NA	4.7	NA	6.3	NA	2.2	NA	2.9
Glabella-Helmet Rim	NA	NA	NA	NA	NA	17.4	NA	NA
Hand Breadth	NA	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Hand Length	NA	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	NA	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	8.7	NA	NA
Hip Breadth, Compressed	1.1	0.8	NA	1.6	1.0	NA	NA	1.7
Hip Breadth, Uncompressed	3.0	1.8	NA	1.8	0.9	NA	NA	1.4
Knee Breadth	9.9	2.3	NA	7.1	1.5	NA	NA	5.9
Knee Circumference	2.3	2.6	NA	3.4	1.2	NA	NA	1.8
Knee Depth	2.2	6.8	NA	3.1	3.9	NA	NA	3.5
Knee Height, Midpatella	0.2	0.2	NA	0.4	0.2	NA	NA	0.4
Knee Height, Sitting	0.4	1.4	NA	0.3	0.7	NA	NA	1.0
Lateral Femoral Epicondyle Height	0.2	0.4	NA	0.2	0.2	NA	NA	0.4

TABLE 12 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Lateral Malleolus Height	5.3	5.4	NA	3.3	7.1	NA	NA	7.4
Menton-Sellion Length	NA	NA	NA	NA	NA	3.8	NA	NA
Menton-Top of Head	NA	NA	NA	NA	NA	1.1	NA	NA
Midshoulder Height	NA	0.3	0.1	0.4	0.3	0.3	0.5	0.3
Midshoulder Height, Sitting	1.1	0.5	0.9	1.1	0.5	0.9	0.6	0.5
Midthigh Breadth	1.8	3.5	NA	3.3	0.9	NA	NA	1.7
Midthigh Circumference	1.6	0.5	NA	1.6	1.7	NA	NA	0.9
Midthigh Depth	1.1	6.1	NA	6.9	7.1	NA	NA	4.0
Midthigh Height	0.3	0.4	NA	0.3	0.4	NA	NA	0.4
Neck Breadth	NA	NA	NA	4.5	NA	2.8	NA	10.5
Neck Circumference	NA	NA	NA	3.1	NA	1.3	NA	1.3
Neck Depth	NA	NA	NA	1.5	NA	3.2	NA	16.8
Neck Height, Lateral	NA	0.3	0.5	0.1	0.2	0.6	0.7	0.3
Popliteal Height	3.1	3.8	NA	1.7	4.0	NA	NA	1.3
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA	2.1	NA	NA
Sellion-Top of Head	NA	NA	NA	NA	NA	3.3	NA	NA
Shoulder Circumference, Compressed	NA	0.9	0.5	1.6	0.9	1.6	1.0	1.2
Shoulder Circumference, Uncompressec	NA	0.9	1.1	1.5	0.9	2.0	0.7	1.2
Sitting Height	0.8	0.5	NA	0.6	0.4	0.3	NA	0.4
Stature	NA	0.3	0.2	0.2	0.2	0.2	0.1	0.2
Thigh Breadth, Crotch	1.1	3.9	NA	6.1	0.9	NA	NA	1.7
Thigh Circumference, Crotch	0.3	0.5	NA	0.6	1.7	NA	NA	0.9
Thigh Clearance	2.2	5.3	NA	2.9	2.7	NA	2.7	1.7
Thigh Depth, Crotch	4.5	5.4	NA	4.0	5.5	NA	NA	3.9
Trochanteric Height	0.2	0.1	NA	0.3	0.2	NA	NA	0.3
Vertical Trunk Circumference (ASCC)	0.6	0.1	0.5	0.6	0.8	1.0	0.6	1.3
Waist Breadth	0.3	1.7	1.4	1.1	1.5	1.0	1.7	0.9
Waist Circumference, Omphalion	1.5	0.3	2.0	1.9	0.2	0.8	1.0	1.1
Waist Depth	4.7	2.1	2.3	2.5	0.9	3.4	1.4	1.0
Waist Height, Omphalion	0.3	0.0	0.7	0.5	0.4	0.2	0.6	0.3
Weight	0.4	0.1	0.0	0.8	0.2	0.0	0.1	0.3
Wrist Breadth	NA	10.9	NA	4.5	NA	2.6	NA	3.2
Wrist Circumference	NA	9.5	NA	2.7	NA	0.9	NA	0.7
Wrist Depth	NA	12.1	NA	6.7	NA	3.3	NA	5.1

CHAPTER 5

INCREMENTAL CHANGES IN CLOTHED BODY SIZE BY LAYER

The mean differences between the nude condition and each layer of the different ensembles are shown in Tables 13 through 20 for each sex. An examination of the data in the tables reveals a somewhat more consistent pattern of incremental change than expected. In cases where the same values appear for succeeding layers it can usually be assumed that the dimension is unchanged because the added layer did not cover the related body part. Occasionally, negative values are reported. This occurred when: (1) the overlayer was constrictive, (2) a compressed measurement produced a smaller value than the nude measurement at the same point, or (3) the clothing reduced the distance between landmarks. Negative increments were found most often among the workspace measurements, e.g., Buttock-Knee Length and Buttock-Popliteal Length, or as a result of lowering in the two principal crotch areas, i.e., Axilla Height and Crotch Height. These dimensions point out the very utilitarian uses that can be made of clothed anthropometry. Figure 1 demonstrates the range of decreases in Crotch Height for successive layers of the ACW ensemble. For this dimension, it is clear that Layers 1 and 2 show the greatest variability among subjects. The garments for these layers are the long-johns and quilted liner respectively, both of which have baggy crotches. Outer garments tend to compress the undergarments, resulting in reduced variability. The upturn of the data trend in Layer 3 is caused by donning the boots. Female subjects showed better fit in the crotch than males. It may be that the women were wearing their trousers higher than the men, or that women obtained an overall tighter fit in the hip and thigh areas of the clothing.

With regard to changes in body size, perhaps the circumferences are the most illuminating. Typically, regardless of ensemble, the largest increases in girth are seen in the shoulder, chest, waist, buttock, and distal limb measurements. Figure 2 illustrates this for the changes in torso and leg circumferences of females in the ACW ensemble. On the torso, Waist Circumference changed the most and Buttock Circumference the least. Of the four leg dimensions, Ankle Circumference shows the greatest overall change.

Figure 3 compares male and female torso circumferences for the ACW ensemble, and Figure 4 makes the same kind of comparison for the leg measurements. The patterns of change are similar for both sexes. Female changes, however, were slightly larger than the male changes for the torso dimensions. This appeared to be due to greater excess material around the torso on the women's clothing or a greater amount of overlap in the jacket and trousers. In the buttocks and thighs, where the clothing fits women more closely, the clothed changes from the nude condition were less than for men.

For any dimension, the amount of increase in size due to clothing will vary among the different subjects for a given clothing layer. The range of variation for Waist Circumference in the ACW ensemble, shown in Figure 5, is approximately 100 mm for Layers 2 through 5,

increases to approximately 350 mm in Layer 6, and decreases somewhat in Layer 7. Smaller subjects, male and female, undergo greater changes in Waist Circumferences throughout all layers than the larger subjects. Much of this is undoubtedly due to differences in clothing fit.

TABLE 13

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta= Grand Mean Layer 1 minus Nude, etc.)
GROUND SOLDIER ENSEMBLE
FEMALES
(Weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	5	9	11	17
Acromion Height	3	36	43	41
Acromion-Radiale Length	0	0	0	0
Ankle Breadth	5	28	86	86
Ankle Circumference	15	88	223	223
Ankle Depth	4	30	79	79
Ankle Height	-5	35	37	37
Axilla (Scye) Height	-9	2	-21	-5
Ball of Foot Circumference	8	61	107	107
Ball of Foot Length	2	17	37	37
Biacromial Breadth	-10	-4	11	33
Biceps Breadth, Flexed	2	44	74	74
Biceps Circumference, Flexed	2	20	145	145
Biceps Depth, Flexed	2	24	41	41
Bideltoid Breadth, Compressed	NA	-18	9	17
Bideltoid Breadth, Uncompressed	1	3	52	69
Bimalleolar Breadth	4	19	67	67
Bitragion (Ear Cup) Breadth	0	104	104	104
Buttock Circumference, Compressed	NA	36	98	98
Buttock Circumference, Uncompressed	2	70	131	131
Buttock Depth, Compressed	NA	95	38	38
Buttock Depth, Uncompressed	5	39	58	58
Buttock Height	0	38	35	35
Buttock-Knee Length	3	4	19	32
Buttock-Popliteal Length	1	-26	-18	-7
Calf Breadth	1	39	49	49
Calf Circumference	5	28	117	117
Calf Depth	0	51	50	50
Calf Height	4	40	44	44
Chest Breadth	20	56	59	75
Chest Circumference	2	34	99	222
Chest Depth	2	18	59	77
Chest Depth - Deltoid Point, Comp	NA	2	29	77
Chest Depth - Deltoid Point, Uncomp	0	2	44	85
Chest Height	0	42	44	47
Crotch Height	0	28	20	20
Deltoid Point Height	6	44	54	49
Ectoorbitale-Top of Head	0	30	44	44
Elbow Breadth	0	21	70	70
Elbow Circumference	0	35	191	191
Elbow Depth	0	90	91	91

TABLE 13 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Eye Height, Sitting	0	4	7	7
Foot Breadth Horizontal	4	8	29	29
Foot Length	3	49	73	73
Forearm Breadth, Flexed	0	44	64	64
Forearm Circumference, Flexed	0	38	142	142
Forearm Depth, Flexed	0	30	40	40
Glabella-Helmet Rim	NA	41	-1	-1
Hand Breadth	0	0	6	6
Hand Circumference	0	0	19	19
Hand Length	0	0	10	10
Hand Thickness	0	0	14	14
Head (Helmet) Breadth	0	56	56	56
Head (Helmet) Length	0	71	71	71
Head (Helmet)Circumference	0	201	201	201
Heel Breadth	4	21	33	33
Helmet Rim-Top of Head	NA	109	99	99
Hip Breadth, Compressed	NA	14	34	34
Hip Breadth, Uncompressed	4	31	47	47
Knee Breadth	0	32	60	60
Knee Circumference	0	31	136	136
Knee Depth	0	54	60	60
Knee Height, Midpatella	1	39	42	42
Knee Height, Sitting	2	38	43	43
Lateral Femoral Epicondyle Height	-1	37	40	40
Lateral Malleolus Height	0	39	43	43
Menton-Sellion Length	0	1	57	57
Menton-Top of Head	0	28	87	87
Midshoulder Height	2	40	43	60
Midshoulder Height, Sitting	1	7	9	33
Midthigh Breadth	0	21	32	32
Midthigh Circumference	0	27	93	93
Midthigh Depth	0	36	44	44
Midthigh Height	5	43	42	42
Neck Breadth	0	23	83	76
Neck Circumference	0	46	171	214
Neck Depth	0	8	71	93
Neck Height, Lateral	-1	36	44	43
Popliteal Height	2	15	-6	-6
Radiale-Stylion Length	0	0	0	0
Sellion-Back of Head	0	24	63	63
Sellion-Top of Head	0	27	33	33
Shoulder Circumference, Compressed	NA	-24	58	152
Shoulder Circumference, Uncompressed	-8	2	103	187
Sitting Height	-2	26	41	41
Stature	2	56	71	67
Thigh Breadth, Crotch	0	17	25	25
Thigh Circumference, Crotch	0	54	91	91

TABLE 13 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Thigh Clearance	0	24	39	39
Thigh Depth, Crotch	0	22	28	28
Trochanteric Height	7	51	42	42
Vertical Trunk Circumference (ASCC)	3	29	101	173
Waist Breadth	17	35	74	96
Waist Circumference, Omphalion	10	72	204	335
Waist Depth	32	41	92	115
Waist Height, Omphalion	-1	36	40	38
Weight	-2	40	92	132
Wrist Breadth	0	21	36	36
Wrist Circumference	0	49	112	112
Wrist Depth	0	23	39	39

TABLE 14

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta= Grand Mean Layer 1 minus nude, etc.)
GROUND SOLDIER ENSEMBLE
MALES
(Weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	1	7	25	31
Acromion Height	0	33	48	51
Acromion-Radiale Length	0	0	0	0
Ankle Breadth	6	41	85	85
Ankle Circumference	15	78	226	226
Ankle Depth	4	22	76	76
Ankle Height	-2	38	45	45
Axilla (Scye) Height	-1	-1	-14	-10
Ball of Foot Circumference	6	57	111	111
Ball of Foot Length	3	14	35	35
Biacromial Breadth	-9	-8	-6	29
Biceps Breadth, Flexed	2	26	64	64
Biceps Circumference, Flexed	-1	12	121	121
Biceps Depth, Flexed	1	15	44	44
Bideltoid Breadth, Compressed	-13	-14	10	21
Bideltoid Breadth, Uncompressed	4	7	36	57
Bimalleolar Breadth	5	15	60	60
Bitragion (Ear Cup) Breadth	0	98	98	98
Buttock Circumference, Compressed	-3	65	160	160
Buttock Circumference, Uncompressed	6	93	196	196
Buttock Depth, Compressed	0	21	63	63
Buttock Depth, Uncompressed	40	94	106	106
Buttock Height	4	39	44	44
Buttock-Knee Length	1	-5	5	27
Buttock-Popliteal Length	1	-40	-48	-23
Calf Breadth	1	30	69	69
Calf Circumference	2	31	122	122
Calf Depth	1	46	37	37
Calf Height	2	45	41	41
Chest Breadth	1	42	14	58
Chest Circumference	7	38	115	244
Chest Depth	13	39	60	92
Chest Depth - Deltoid Point, Comp	-1	0	16	59
Chest Depth - Deltoid Point, Uncomp	6	14	33	67
Chest Height	5	38	45	45
Crotch Height	2	-16	-21	-21
Deltoid Point Height	8	51	57	56
Ectoorbitale-Top of Head	0	32	41	41
Elbow Breadth	0	22	43	43
Elbow Circumference	0	35	162	162
Elbow Depth	0	80	88	88

TABLE 14 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Eye Height, Sitting	2	6	7	7
Foot Breadth Horizontal	5	8	29	29
Foot Length	6	46	79	79
Forearm Breadth, Flexed	0	26	45	45
Forearm Circumference, Flexed	0	34	107	107
Forearm Depth, Flexed	0	37	41	41
Glabella-Helmet Rim	NA	42	0	0
Hand Breadth	0	0	6	6
Hand Circumference	0	0	22	22
Hand Length	0	0	7	7
Hand Thickness	0	0	15	15
Head (Helmet) Breadth	0	54	54	54
Head (Helmet) Length	0	74	74	74
Head (Helmet)Circumference	0	205	205	205
Heel Breadth	6	24	39	39
Helmet Rim-Top of Head	NA	118	111	111
Hip Breadth, Compressed	-2	19	52	52
Hip Breadth, Uncompressed	10	54	79	79
Knee Breadth	0	36	55	55
Knee Circumference	0	42	170	170
Knee Depth	0	75	101	101
Knee Height, Midpatella	-2	32	37	37
Knee Height, Sitting	0	38	47	47
Lateral Femoral Epicondyle Height	-3	33	39	39
Lateral Malleolus Height	-3	38	44	44
Menton-Sellion Length	0	4	48	48
Menton-Top of Head	0	37	88	88
Midshoulder Height	2	36	46	55
Midshoulder Height, Sitting	2	7	18	36
Midthigh Breadth	0	24	38	38
Midthigh Circumference	0	39	96	96
Midthigh Depth	0	56	67	67
Midthigh Height	-3	30	34	34
Neck Breadth	0	37	79	81
Neck Circumference	0	44	139	158
Neck Depth	0	10	68	84
Neck Height, Lateral	1	37	46	49
Popliteal Height	-2	0	-15	-15
Radiale-Stylion Length	0	0	0	0
Sellion-Back of Head	0	27	65	65
Sellion-Top of Head	0	36	42	42
Shoulder Circumference, Compressed	-15	-19	55	133
Shoulder Circumference, Uncompressed	-5	0	89	153
Sitting Height	0	31	38	38
Stature	0	61	70	70
Thigh Breadth, Crotch	0	21	25	25
Thigh Circumference, Crotch	0	62	104	104

TABLE 14 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Thigh Clearance	0	30	40	40
Thigh Depth, Crotch	0	57	59	59
Trochanteric Height	7	35	36	36
Vertical Trunk Circumference (ASCC)	-11	59	141	211
Waist Breadth	13	42	85	86
Waist Circumference, Omphalion	0	51	188	308
Waist Depth	44	79	111	130
Waist Height, Omphalion	-3	33	39	41
Weight	2	55	111	153
Wrist Breadth	0	21	27	27
Wrist Circumference	0	42	96	96
Wrist Depth	0	25	35	35

TABLE 15

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc.)
AVIATOR WARM WEATHER ENSEMBLE
FEMALES
(Weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	5	9	13	18	12
Acromion Height	3	36	39	40	40
Acromion-Radiale Length	0	0	0	0	0
Ankle Breadth	5	52	52	52	83
Ankle Circumference	15	112	112	112	220
Ankle Depth	4	65	65	65	73
Ankle Height	-5	35	35	35	45
Axilla (Scye) Height	-9	21	-2	4	-6
Ball of Foot Circumference	8	61	61	61	107
Ball of Foot Length	2	17	17	17	37
Biacromial Breadth	-10	1	-2	-12	23
Biceps Breadth, Flexed	2	28	39	39	87
Biceps Circumference, Flexed	2	-6	44	44	148
Biceps Depth, Flexed	2	14	35	35	47
Bideltoid Breadth, Compressed	-15	-20	-11	-11	30
Bideltoid Breadth, Uncompressed	1	8	31	31	75
Bimalleolar Breadth	4	27	27	27	67
Bitragion (Ear Cup) Breadth	0	166	166	166	166
Buttock Circumference, Compressed	-25	-26	-26	8	83
Buttock Circumference, Uncompressed	2	6	6	41	120
Buttock Depth, Compressed	-9	-4	-4	10	37
Buttock Depth, Uncompressed	5	13	13	20	70
Buttock Height	0	37	37	35	42
Buttock-Knee Length	3	0	1	1	19
Buttock-Popliteal Length	1	-43	-39	-39	-24
Calf Breadth	1	33	33	33	59
Calf Circumference	5	20	20	20	93
Calf Depth	0	59	59	59	50
Calf Height	4	37	37	37	39
Chest Breadth	20	36	71	76	82
Chest Circumference	2	8	33	226	290
Chest Depth	2	11	50	80	115
Chest Depth - Deltoid Point, Comp	-5	1	9	96	114
Chest Depth - Deltoid Point, Uncomp	0	6	26	95	119
Chest Height	0	37	35	37	44
Crotch Height	0	9	9	11	-31
Deltoid Point Height	6	47	52	51	52
Ectoorbitale-Top of Head	0	49	49	49	62
Elbow Breadth	0	18	29	29	68
Elbow Circumference	0	2	46	46	186
Elbow Depth	0	46	77	77	93

TABLE 15 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Eye Height, Sitting	0	1	1	1	8
Foot Breadth Horizontal	4	8	8	8	29
Foot Length	3	49	49	49	73
Forearm Breadth, Flexed	0	35	46	46	70
Forearm Circumference, Flexed	0	6	60	60	150
Forearm Depth, Flexed	0	24	36	36	46
Glabella-Helmet Rim	NA	51	51	51	7
Hand Breadth	0	6	6	6	6
Hand Circumference	0	10	10	10	19
Hand Length	0	28	28	28	10
Hand Thickness	0	4	4	4	14
Head (Helmet) Breadth	0	91	91	91	91
Head (Helmet) Length	0	103	103	103	103
Head (Helmet)Circumference	0	310	310	310	310
Heel Breadth	4	21	21	21	33
Helmet Rim-Top of Head	NA	131	131	131	126
Hip Breadth, Compressed	-9	-7	-7	-7	20
Hip Breadth, Uncompressed	4	6	6	6	43
Knee Breadth	0	40	40	40	51
Knee Circumference	0	2	2	2	114
Knee Depth	0	48	48	48	64
Knee Height, Midpatella	1	38	38	38	45
Knee Height, Sitting	2	33	33	33	39
Lateral Femoral Epicondyle Height	-1	36	36	36	41
Lateral Malleolus Height	0	32	32	32	44
Menton-Sellion Length	0	0	0	0	57
Menton-Top of Head	0	44	44	44	118
Midshoulder Height	2	37	45	43	43
Midshoulder Height, Sitting	1	5	13	11	11
Midthigh Breadth	0	15	15	15	30
Midthigh Circumference	0	0	0	0	82
Midthigh Depth	0	19	19	19	64
Midthigh Height	5	36	36	36	47
Neck Breadth	0	35	45	45	77
Neck Circumference	0	57	87	87	183
Neck Depth	0	18	19	19	85
Neck Height, Lateral	-1	34	38	37	40
Popliteal Height	2	6	6	6	-7
Radiale-Stylion Length	0	0	0	0	0
Sellion-Back of Head	0	94	94	94	81
Sellion-Top of Head	0	47	47	47	65
Shoulder Circumference, Compressed	-25	-29	1	122	228
Shoulder Circumference, Uncompressed	-8	0	36	162	267
Sitting Height	-2	44	44	44	49
Stature	2	75	75	68	81
Thigh Breadth, Crotch	0	8	8	12	18
Thigh Circumference, Crotch	0	0	0	39	53

TABLE 15 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Thigh Clearance	0	18	18	18	38
Thigh Depth, Crotch	0	22	22	51	39
Trochanteric Height	7	41	41	41	45
Vertical Trunk Circumference (ASCC)	3	19	28	121	222
Waist Breadth	17	3	54	76	94
Waist Circumference, Omphalion	10	11	94	341	386
Waist Depth	32	20	58	101	120
Waist Height, Omphalion	-1	41	34	35	40
Weight	-2	36	40	106	160
Wrist Breadth	0	20	15	15	38
Wrist Circumference	0	53	39	39	120
Wrist Depth	0	20	14	14	44

TABLE 16

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc.)
AVIATOR WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	1	9	13	26	28
Acromion Height	0	39	38	44	48
Acromion-Radiale Length	0	0	0	0	0
Ankle Breadth	6	54	54	54	79
Ankle Circumference	15	99	99	99	228
Ankle Depth	4	45	45	45	76
Ankle Height	-2	40	40	40	44
Axilla (Scye) Height	-1	11	-14	-13	-18
Ball of Foot Circumference	6	57	57	57	111
Ball of Foot Length	3	14	14	14	35
Biacromial Breadth	-9	-22	-2	-23	8
Biceps Breadth, Flexed	2	26	37	37	81
Biceps Circumference, Flexed	-1	-6	41	41	144
Biceps Depth, Flexed	1	13	28	28	49
Bideltoid Breadth, Compressed	-13	-12	1	1	21
Bideltoid Breadth, Uncompressed	4	7	26	26	46
Bimalleolar Breadth	5	30	30	30	65
Bitragion (Ear Cup) Breadth	0	152	452	152	152
Buttock Circumference, Compressed	-3	0	0	27	134
Buttock Circumference, Uncompressed	6	28	28	58	174
Buttock Depth, Compressed	0	10	10	20	65
Buttock Depth, Uncompressed	40	40	40	37	112
Buttock Height	4	38	38	40	41
Buttock-Knee Length	1	2	30	3	11
Buttock-Popliteal Length	1	-59	-58	-58	-44
Calf Breadth	1	35	35	35	70
Calf Circumference	2	30	30	30	122
Calf Depth	1	70	70	70	34
Calf Height	2	44	44	44	46
Chest Breadth	1	20	31	59	48
Chest Circumference	7	15	48	257	298
Chest Depth	13	28	64	103	133
Chest Depth - Deltoid Point, Comp	-1	-3	0	72	75
Chest Depth - Deltoid Point, Uncomp	6	6	23	75	87
Chest Height	5	35	38	39	41
Crotch Height	2	-34	-34	-11	-33
Deltoid Point Height	8	55	54	63	64
Ectoorbitale-Top of Head	0	45	45	45	64
Elbow Breadth	0	23	27	27	51
Elbow Circumference	0	11	67	67	179
Elbow Depth	0	45	66	66	93

TABLE 16 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Eye Height, Sitting	2	-1	-1	-1	-4
Foot Breadth Horizontal	5	8	8	8	29
Foot Length	6	46	46	46	79
Forearm Breadth, Flexed	0	18	28	28	57
Forearm Circumference, Flexed	0	3	45	45	126
Forearm Depth, Flexed	0	14	28	28	40
Glabella-Helmet Rim	NA	45	45	45	5
Hand Breadth	0	5	5	5	6
Hand Circumference	0	10	10	10	22
Hand Length	0	6	6	6	7
Hand Thickness	0	7	7	7	15
Head (Helmet) Breadth	0	83	83	83	83
Head (Helmet) Length	0	91	91	91	91
Head (Helmet)Circumference	0	283	283	283	283
Heel Breadth	6	24	24	24	39
Helmet Rim-Top of Head	NA	134	134	134	131
Hip Breadth, Compressed	-2	1	1	1	32
Hip Breadth, Uncompressed	10	22	22	22	72
Knee Breadth	0	45	45	45	54
Knee Circumference	0	23	23	23	165
Knee Depth	0	76	76	76	106
Knee Height, Midpatella	-2	38	38	38	37
Knee Height, Sitting	0	39	39	39	46
Lateral Femoral Epicondyle Height	-3	45	45	45	47
Lateral Malleolus Height	-3	39	39	39	47
Menton-Sellion Length	0	0	0	0	47
Menton-Top of Head	0	50	50	50	107
Midshoulder Height	2	38	39	32	53
Midshoulder Height, Sitting	2	5	11	12	29
Midthigh Breadth	0	21	21	21	36
Midthigh Circumference	0	13	13	13	98
Midthigh Depth	0	54	54	54	80
Midthigh Height	-3	39	39	39	38
Neck Breadth	0	36	55	55	67
Neck Circumference	0	72	99	99	155
Neck Depth	0	18	29	29	75
Neck Height, Lateral	1	39	42	40	46
Popliteal Height	-2	-6	-6	-6	-26
Radiale-Stylion Length	0	0	0	0	0
Sellion-Back of Head	0	82	82	82	74
Sellion-Top of Head	0	50	50	50	70
Shoulder Circumference, Compressed	-15	-17	17	122	178
Shoulder Circumference, Uncompressed	-5	5	41	144	200
Sitting Height	0	45	45	145	49
Stature	0	77	75	76	80
Thigh Breadth, Crotch	0	11	11	21	25
Thigh Circumference, Crotch	0	8	8	42	90

TABLE 16 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Thigh Clearance	0	20	20	20	40
Thigh Depth, Crotch	0	56	56	43	74
Trochanteric Height	7	35	35	35	41
Vertical Trunk Circumference (ASCC)	-11	45	65	124	211
Waist Breadth	13	18	57	53	99
Waist Circumference, Omphalion	0	32	110	308	384
Waist Depth	44	30	84	95	157
Waist Height, Omphalion	-3	37	37	35	37
Weight	2	47	55	124	175
Wrist Breadth	0	12	14	14	30
Wrist Circumference	0	31	42	42	102
Wrist Depth	0	17	17	17	34

TABLE 17

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc.)
AVIATOR COLD WEATHER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	2	15	18	14	20	21	21
Acromion Height	3	6	40	39	39	38	48
Acromion-Radiale Length	0	0	0	0	0	0	0
Ankle Breadth	11	105	54	91	91	91	96
Ankle Circumference	28	79	138	283	283	283	281
Ankle Depth	9	72	59	97	97	97	91
Ankle Height	-6	4	37	33	33	33	42
Axilla (Scye) Height	-9	-11	22	22	-15	-6	1
Ball of Foot Circumference	8	8	61	61	61	61	107
Ball of Foot Length	1	1	17	17	17	17	37
Biacromial Breadth	-10	-8	7	7	24	19	44
Biceps Breadth, Flexed	2	55	43	43	61	61	95
Biceps Circumference, Flexed	2	48	67	67	137	137	219
Biceps Depth, Flexed	2	33	32	32	45	45	57
Bideltoid Breadth, Compressed	-15	-17	-2	-2	17	17	65
Bideltoid Breadth, Uncompressed	1	18	31	31	62	62	109
Bimalleolar Breadth	3	79	34	73	73	73	86
Bitragion (Ear-Cup) Breadth	0	0	166	166	166	166	166
Buttock Circumference, Compressed	-14	13	23	82	82	106	160
Buttock Circumference, Uncompressed	15	52	60	125	125	145	204
Buttock Depth, Compressed	-3	9	19	32	32	44	66
Buttock Depth, Uncompressed	15	37	33	50	50	54	90
Buttock Height	-4	0	37	36	36	36	41
Buttock-Knee Length	1	5	10	17	24	24	28
Buttock-Popliteal Length	-16	-37	-42	-43	-42	-42	-20
Calf Breadth	3	48	43	59	59	59	81
Calf Circumference	11	61	111	208	208	208	232
Calf Depth	3	55	68	81	81	81	72

TABLE 17 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Calf Height	-2	-2	38	39	39	39	44
Chest Breadth	20	62	64	64	101	99	94
Chest Circumference	2	40	60	78	171	349	365
Chest Depth	2	40	38	39	86	123	154
Chest Depth - Deltoid Point, Comp	-5	6	22	30	42	116	149
Chest Depth - Deltoid Point, Uncomp	0	20	32	36	59	115	153
Chest Height	0	-1	46	46	42	45	49
Crotch Height	-9	-60	9	-40	-40	-46	-31
Deltoid Point Height	6	15	48	48	52	48	53
Ectoorbitale-Top of Head	0	0	49	49	49	49	62
Elbow Breadth	0	45	35	35	46	46	73
Elbow Circumference	0	55	86	86	178	178	240
Elbow Depth	0	81	64	64	87	87	103
Eye Height, Sitting	2	5	9	4	4	4	0
Foot Breadth Horizontal	4	4	8	8	8	8	29
Foot Length	3	3	49	49	49	49	73
Forearm Breadth, Flexed	0	60	49	49	57	57	78
Forearm Circumference, Flexed	0	65	74	74	152	152	191
Forearm Depth, Flexed	0	29	23	23	42	42	49
Glabella-Helmet Rim	NA	NA	51	51	51	51	7
Hand Breadth	0	0	6	6	6	6	6
Hand Circumference	0	0	10	10	10	10	19
Hand Length	0	0	28	28	28	28	10
Hand Thickness	0	0	4	4	4	4	14
Head (Helmet) Breadth	0	0	91	91	91	91	91
Head (Helmet) Length	0	0	103	103	103	103	103
Head (Helmet)Circumference	0	0	310	310	310	310	310
Heel Breadth	4	4	21	21	21	21	33
Helmet Rim-Top of Head	NA	NA	131	131	131	131	126
Hip Breadth, Compressed	-3	4	7	30	30	30	44
Hip Breadth, Uncompressed	4	20	20	43	43	43	56
Knee Breadth	2	55	56	69	69	69	77
Knee Circumference	8	55	108	226	226	226	261
Knee Depth	2	51	58	88	88	88	94

TABLE 17 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Knee Height, Midpatella	4	4	40	40	40	40	42
Knee Height, Sitting	1	2	36	40	40	40	50
Lateral Femoral Epicondyle Height	-3	-4	37	37	37	37	40
Lateral Malleolus Height	-2	9	46	40	40	40	50
Menton-Sellion Length	0	0	0	0	0	0	57
Menton-Top of Head	0	0	44	44	44	44	118
Midshoulder Height	2	6	45	46	46	48	53
Midshoulder Height, Sitting	-1	13	19	15	23	25	17
Midthigh Breadth	0	19	26	42	42	42	56
Midthigh Circumference	-4	40	55	146	146	146	213
Midthigh Depth	3	65	44	62	62	62	89
Midthigh Height	-1	1	36	38	38	38	43
Neck Breadth	0	0	38	38	63	63	83
Neck Circumference	0	0	94	94	170	170	241
Neck Depth	0	0	26	26	44	44	88
Neck Height, Lateral	-1	-2	36	38	35	37	45
Popliteal Height	-13	-40	-2	-16	-16	-16	-16
Radiale-Stylion Length	0	0	0	0	0	0	0
Sellion-Back of Head	0	0	94	94	94	94	81
Sellion-Top of Head	0	0	47	47	47	47	65
Shoulder Circumference, Compressed	-25	-22	26	32	230	230	317
Shoulder Circumference, Uncompressed	-8	17	80	87	157	275	379
Sitting Height	-4	1	49	45	45	45	45
Stature	2	-1	78	75	74	68	83
Thigh Breadth, Crotch	6	11	19	32	32	38	44
Thigh Circumference, Crotch	10	23	53	105	105	125	165
Thigh Clearance	7	37	35	51	51	51	63
Thigh Depth, Crotch	10	52	40	44	44	64	58
Trochanteric Height	1	4	39	36	36	36	46
Vertical Trunk Circumference (ASCC)	-8	60	62	167	193	277	295
Waist Breadth	19	24	19	52	75	95	113
Waist Circumference, Omphalion	27	85	96	184	251	446	449
Waist Depth	27	49	51	72	95	149	158
Waist Height, Omphalion	0	2	38	38	37	38	42

TABLE 17 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Weight	-2	7	51	66	76	145	498
Wrist Breadth	0	57	24	24	14	14	41
Wrist Circumference	0	61	81	81	43	43	134
Wrist Depth	0	86	35	35	18	18	46

TABLE 18

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc.)
AVIATOR COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	10	20	23	22	19	20	25
Acromion Height	0	7	43	43	35	36	43
Acromion-Radiale Length	0	0	0	0	0	0	0
Ankle Breadth	13	105	60	103	103	103	101
Ankle Circumference	26	106	166	275	275	275	291
Ankle Depth	9	77	67	93	93	93	87
Ankle Height	4	-3	37	31	31	31	47
Axilla (Scye) Height	-1	-21	14	14	-17	-19	-7
Ball of Foot Circumference	6	6	57	57	57	57	111
Ball of Foot Length	3	3	14	14	14	14	35
Biacromial Breadth	-9	-21	-16	-16	31	31	41
Biceps Breadth, Flexed	2	49	45	45	55	55	81
Biceps Circumference, Flexed	-1	46	59	59	112	112	183
Biceps Depth, Flexed	1	30	27	27	39	39	56
Bideltoid Breadth, Compressed	-13	-9	-2	-2	22	22	57
Bideltoid Breadth, Uncompressed	4	21	17	17	48	48	86
Bimalleolar Breadth	7	72	32	76	76	76	78
Bitragion (Ear Cup) Breadth	0	0	152	152	152	152	152
Buttock Circumference, Compressed	16	47	58	135	135	157	208
Buttock Circumference, Uncompressed	26	74	89	169	169	195	249
Buttock Depth, Compressed	5	24	33	52	52	59	77
Buttock Depth, Uncompressed	49	68	57	78	78	76	118
Buttock Height	1	-1	37	38	38	34	38
Buttock-Knee Length	6	8	4	11	14	14	24
Buttock-Popliteal Length	-15	-44	-54	-58	-57	-53	-41
Calf Breadth	6	48	45	68	68	68	89
Calf Circumference	9	70	121	203	203	203	219
Calf Depth	5	65	69	81	81	81	60

TABLE 18 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Calf Height	6	6	38	38	38	38	41
Chest Breadth	1	31	27	27	76	67	65
Chest Circumference	7	44	53	74	167	306	361
Chest Depth	13	48	45	43	96	120	154
Chest Depth - Deltoid Point, Comp	-1	-2	9	16	27	95	111
Chest Depth - Deltoid Point, Uncomp	6	16	22	22	47	111	119
Chest Height	5	4	40	41	37	35	42
Crotch Height	-64	-83	-23	-60	-60	-74	-71
Deltoid Point Height	8	22	56	50	53	50	50
Ectoorbitale-Top of Head	0	0	45	45	45	45	64
Elbow Breadth	0	31	29	29	33	33	60
Elbow Circumference	0	64	78	78	157	157	208
Elbow Depth	0	73	63	63	82	82	100
Eye Height, Sitting	2	4	7	6	6	6	-3
Foot Breadth Horizontal	5	5	8	8	8	8	29
Foot Length	6	6	46	46	46	46	79
Forearm Breadth, Flexed	0	38	38	38	39	39	57
Forearm Circumference, Flexed	0	53	67	67	107	107	151
Forearm Depth, Flexed	0	32	21	21	33	33	49
Glabella-Helmet Rim	NA	NA	45	45	45	45	5
Hand Breadth	0	0	5	5	5	5	6
Hand Circumference	0	0	10	10	10	10	22
Hand Length	0	0	6	6	6	6	7
Hand Thickness	0	0	7	7	7	7	15
Head (Helmet) Breadth	0	0	83	83	83	83	83
Head (Helmet) Length	0	0	91	91	91	91	91
Head (Helmet)Circumference	0	0	283	283	283	283	283
Heel Breadth	6	6	24	24	24	24	39
Helmet Rim-Top of Head	NA	NA	134	134	134	134	131
Hip Breadth, Compressed	4	10	15	46	46	46	71
Hip Breadth, Uncompressed	17	33	34	64	64	64	101
Knee Breadth	5	57	59	78	78	78	88
Knee Circumference	7	91	120	256	256	256	293
Knee Depth	9	80	77	105	105	105	104

TABLE 18 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Knee Height, Midpatella	-2	-2	34	36	36	36	38
Knee Height, Sitting	4	6	41	43	43	43	48
Lateral Femoral Epicondyle Height	2	6	41	45	45	45	47
Lateral Malleolus Height	3	2	40	40	40	40	50
Menton-Sellion Length	0	0	0	0	0	0	47
Menton-Top of Head	0	0	50	50	50	50	107
Midshoulder Height	2	7	42	42	39	35	41
Midshoulder Height, Sitting	7	14	16	16	19	23	16
Midthigh Breadth	4	34	43	54	54	54	67
Midthigh Circumference	0	54	76	178	178	178	223
Midthigh Depth	4	81	62	87	87	87	101
Midthigh Height	-5	0	39	38	38	38	36
Neck Breadth	0	0	38	38	65	64	81
Neck Circumference	0	0	85	85	168	169	186
Neck Depth	0	0	30	30	54	52	77
Neck Height, Lateral	1	6	43	41	36	36	42
Popliteal Height	-25	-50	-17	-31	-31	-31	-33
Radiale-Stylion Length	0	0	0	0	0	0	0
Sellion-Back of Head	0	0	82	82	82	82	74
Sellion-Top of Head	0	0	50	50	50	50	70
Shoulder Circumference, Compressed	-15	-2	27	31	97	198	275
Shoulder Circumference, Uncompressed	-5	26	61	61	128	228	305
Sitting Height	-1	4	51	54	54	54	58
Stature	0	1	79	79	76	72	87
Thigh Breadth, Crotch	3	22	33	40	40	46	54
Thigh Circumference, Crotch	4	51	75	152	452	154	197
Thigh Clearance	12	36	42	53	53	53	67
Thigh Depth, Crotch	6	84	66	77	77	76	10
Trochanteric Height	2	-3	37	36	36	36	35
Vertical Trunk Circumference (ASCC)	33	119	103	166	189	265	316
Waist Breadth	13	38	32	54	60	81	116
Waist Circumference, Omphalion	0	87	102	183	214	404	441
Waist Depth	44	48	45	65	80	126	167
Waist Height, Omphalion	-3	1	37	35	34	37	37

TABLE 18 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Weight	9	17	61	79	86	151	207
Wrist Breadth	0	40	22	22	15	15	31
Wrist Circumference	0	52	81	81	46	46	111
Wrist Depth	0	73	31	31	16	16	40

TABLE 19

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc.)
COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Acromial Height, Sitting	1	1	1	22	17	18
Acromion Height	0	0	3	39	42	42
Acromion-Radiale Length	0	0	0	0	0	0
Ankle Breadth	6	6	6	41	41	83
Ankle Circumference	15	15	15	110	110	227
Ankle Depth	4	4	4	37	37	73
Ankle Height	-2	-2	-2	45	45	43
Axilla (Scye) Height	-1	-1	-1	-19	-19	-8
Ball of Foot Circumference	6	6	6	57	57	111
Ball of Foot Length	3	3	3	14	14	35
Biacromial Breadth	-9	-9	-9	-12	-7	9
Biceps Breadth, Flexed	2	2	2	22	22	66
Biceps Circumference, Flexed	-1	-1	-1	9	9	121
Biceps Depth, Flexed	1	1	1	34	34	41
Bideltoid Breadth, Compressed	-13	-13	-13	-15	-15	12
Bideltoid Breadth, Uncompressed	4	4	4	17	17	46
Bimalleolar Breadth	5	5	5	18	18	57
Bitragion (Ear Cup) Breadth	0	0	0	129	129	135
Buttock Circumference, Compressed	-3	-3	-3	13	13	94
Buttock Circumference, Uncompressed	6	6	6	49	49	151
Buttock Depth, Compressed	0	0	0	12	12	41
Buttock Depth, Uncompressed	40	40	40	45	45	96
Buttock Height	4	4	4	38	38	40
Buttock-Knee Length	1	1	1	-4	2	21
Buttock-Popliteal Length	1	1	0	-50	-41	-32
Calf Breadth	1	1	1	26	26	58
Calf Circumference	2	2	2	44	44	128
Calf Depth	1	1	1	47	47	37

TABLE 19 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Calf Height	2	2	2	46	46	47
Chest Breadth	1	1	29	59	47	64
Chest Circumference	7	64	121	162	184	255
Chest Depth	13	58	71	73	80	122
Chest Depth - Deltoid Point, Comp	-1	41	59	55	61	78
Chest Depth - Deltoid Point, Uncomp	6	50	64	62	72	88
Chest Height	5	2	-3	41	42	45
Crotch Height	2	2	2	-28	-28	-55
Deltoid Point Height	8	10	12	50	52	52
Ectoorbitale-Top of Head	0	0	0	39	39	42
Elbow Breadth	0	0	0	18	18	40
Elbow Circumference	0	0	0	22	22	154
Elbow Depth	0	0	0	70	70	90
Eye Height, Sitting	2	2	2	-5	-5	-6
Foot Breadth Horizontal	5	5	5	8	8	29
Foot Length	6	6	6	46	46	79
Forearm Breadth, Flexed	0	0	0	28	28	45
Forearm Circumference, Flexed	0	0	0	18	18	98
Forearm Depth, Flexed	0	0	0	20	20	29
Glabella-Helmet Rim	NA	NA	NA	25	25	-15
Hand Breadth	0	0	0	3	3	6
Hand Circumference	0	0	0	8	8	22
Hand Length	0	0	0	4	4	7
Hand Thickness	0	0	0	7	7	15
Head (Helmet) Breadth	0	0	0	77	77	77
Head (Helmet) Length	0	0	0	70	70	71
Head (Helmet)Circumference	0	0	0	212	212	212
Heel Breadth	6	6	6	24	24	39
Helmet Rim-Top of Head	NA	NA	NA	106	106	104
Hip Breadth, Compressed	-2	-2	-2	5	5	30
Hip Breadth, Uncompressed	10	10	10	21	21	65
Knee Breadth	0	0	0	36	36	63
Knee Circumference	0	0	0	44	44	171
Knee Depth	0	0	0	69	69	81

TABLE 19 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Knee Height, Midpatella	-2	-2	-2	36	36	38
Knee Height, Sitting	0	0	0	41	41	45
Lateral Femoral Epicondyle Height	-3	-3	-3	44	44	44
Lateral Malleolus Height	-3	-3	-3	48	48	45
Menton-Sellion Length	0	0	0	0	0	48
Menton-Top of Head	0	0	0	43	43	80
Midshoulder Height	2	2	0	42	46	44
Midshoulder Height, Sitting	2	2	4	21	22	16
Midthigh Breadth	0	0	0	27	27	44
Midthigh Circumference	0	0	0	32	32	98
Midthigh Depth	0	0	0	53	53	64
Midthigh Height	-3	-3	-3	40	40	41
Neck Breadth	0	76	76	41	41	65
Neck Circumference	0	216	216	74	74	150
Neck Depth	0	0	0	16	16	65
Neck Height, Lateral	1	1	1	37	41	41
Popliteal Height	-2	-2	-2	-14	-14	-22
Radiale-Stylion Length	0	0	0	0	0	0
Sellion-Back of Head	0	0	0	37	37	78
Sellion-Top of Head	0	0	0	41	41	38
Shoulder Circumference, Compressed	-15	3	29	27	53	124
Shoulder Circumference, Uncompressed	-5	18	49	51	83	161
Sitting Height	0	0	0	34	34	36
Stature	0	-1	0	66	66	69
Thigh Breadth, Crotch	0	0	0	16	16	28
Thigh Circumference, Crotch	0	0	0	23	23	71
Thigh Clearance	0	0	0	26	26	38
Thigh Depth, Crotch	0	0	0	56	56	59
Trochanteric Height	7	7	7	37	37	41
Vertical Trunk Circumference (ASCC)	-11	-16	11	81	115	204
Waist Breadth	13	13	50	57	77	86
Waist Circumference, Omphalion	0	13	147	183	326	342
Waist Depth	44	32	58	81	121	143
Waist Height, Omphalion	-3	1	1	34	37	39

TABLE 19 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Weight	2	9	26	74	80	137
Wrist Breadth	0	0	0	22	22	39
Wrist Circumference	0	0	0	67	67	113
Wrist Depth	0	0	0	27	27	35

TABLE 20

MEAN DELTAS BETWEEN CLOTHED AND NUDE CONDITIONS
(Delta = Grand Mean Layer 1 minus Nude, etc)
COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Acromial Height, Sitting	10.0	20.0	20.0	14.0	16.0	22.0	22.0	20.0
Acromion Height	0.0	7.0	10.0	39.0	41.0	38.0	38.0	40.0
Acromion-Radiale Length	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ankle Breadth	13.0	105.0	105.0	56.0	110.0	110.0	110.0	99.0
Ankle Circumference	26.0	106.0	106.0	133.0	282.0	282.0	282.0	287.0
Ankle Depth	9.0	77.0	77.0	41.0	96.0	96.0	96.0	90.0
Ankle Height	4.0	-3.0	-3.0	44.0	35.0	35.0	35.0	48.0
Axilla (Scye) Height	-1.0	-21.0	-17.0	-40.0	-40.0	-25.0	-25.0	-18.0
Ball of Foot Circumference	6.0	6.0	6.0	57.0	57.0	57.0	57.0	111.0
Ball of Foot Length	3.0	3.0	3.0	14.0	14.0	14.0	14.0	35.0
Biacromial Breadth	-9.0	-21.0	-21.0	-7.0	-7.0	16.0	16.0	67.0
Biceps Breadth, Flexed	2.0	49.0	49.0	40.0	40.0	56.0	56.0	80.0
Biceps Circumference, Flexed	-1.0	46.0	46.0	48.0	48.0	122.0	122.0	179.0
Biceps Depth, Flexed	1.0	30.0	30.0	30.0	30.0	41.0	41.0	51.0
Bideltoid Breadth, Compressed	-13.0	-9.0	-9.0	1.0	1.0	23.0	23.0	60.0
Bideltoid Breadth, Uncompressed	4.0	21.0	21.0	41.0	41.0	50.0	50.0	90.0
Bimalleolar Breadth	7.0	72.0	72.0	46.0	78.0	78.0	78.0	77.0
Bitragion (Ear Cup) Breadth	0.0	0.0	0.0	129.0	129.0	137.0	137.0	135.0
Buttock Circumference, Compressed	16.0	47.0	47.0	75.0	162.0	162.0	162.0	194.0
Buttock Circumference, Uncompressed	26.0	74.0	74.0	108.0	198.0	198.0	198.0	224.0
Buttock Depth, Compressed	5.0	24.0	24.0	32.0	61.0	61.0	61.0	73.0
Buttock Depth, Uncompressed	49.0	68.0	68.0	59.0	83.0	83.0	83.0	97.0
Buttock Height	1.0	-1.0	-1.0	36.0	39.0	39.0	39.0	38.0
Buttock-Knee Length	6.0	8.0	8.0	9.0	20.0	28.0	30.0	40.0
Buttock-Popliteal Length	-15.0	-44.0	-44.0	-42.0	-51.0	-43.0	-41.0	-31.0
Calf Breadth	6.0	48.0	48.0	41.0	76.0	76.0	76.0	82.0

TABLE 20 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Calf Circumference	9.0	70.0	70.0	106.0	212.0	212.0	212.0	212.0
Calf Depth	5.0	65.0	65.0	44.0	75.0	75.0	75.0	65.0
Calf Height	6.0	6.0	6.0	42.0	39.0	39.0	39.0	45.0
Chest Breadth	1.0	31.0	25.0	54.0	54.0	69.0	66.0	75.0
Chest Circumference	7.0	44.0	101.0	148.0	160.0	206.0	242.0	308.0
Chest Depth	13.0	48.0	47.0	57.0	60.0	96.0	100.0	139.0
Chest Depth - Deltoid Point, Comp	-1.0	-2.0	24.0	29.0	33.0	43.0	60.0	85.0
Chest Depth - Deltoid Point, Uncomp	6.0	16.0	32.0	37.0	38.0	60.0	79.0	99.0
Chest Height	5.0	4.0	6.0	36.0	39.0	38.0	40.0	41.0
Crotch Height	-64.0	-83.0	-83.0	-29.0	-65.0	-65.0	-65.0	-65.0
Deltoid Point Height	8.0	22.0	20.0	52.0	52.0	59.0	54.0	56.0
Ectoorbitale-Top of Head	0.0	0.0	0.0	39.0	39.0	46.0	46.0	42.0
Elbow Breadth	0.0	31.0	31.0	32.0	32.0	34.0	34.0	56.0
Elbow Circumference	0.0	64.0	64.0	92.0	92.0	154.0	154.0	206.0
Elbow Depth	0.0	73.0	73.0	76.0	76.0	84.0	84.0	98.0
Eye Height, Sitting	2.0	4.0	4.0	3.0	-3.0	-3.0	-3.0	8.0
Foot Breadth Horizontal	5.0	5.0	5.0	8.0	8.0	8.0	8.0	29.0
Foot Length	6.0	6.0	6.0	46.0	46.0	46.0	46.0	79.0
Forearm Breadth, Flexed	0.0	38.0	38.0	44.0	44.0	42.0	42.0	51.0
Forearm Circumference, Flexed	0.0	53.0	53.0	76.0	76.0	107.0	107.0	142.0
Forearm Depth, Flexed	0.0	32.0	32.0	29.0	29.0	38.0	38.0	43.0
Glabella-Helmet Rim	NA	NA	NA	25.0	25.0	23.0	23.0	-15.0
Hand Breadth	0.0	0.0	0.0	3.0	3.0	3.0	3.0	6.0
Hand Circumference	0.0	0.0	0.0	8.0	8.0	8.0	8.0	22.0
Hand Length	0.0	0.0	0.0	4.0	4.0	4.0	4.0	7.0
Hand Thickness	0.0	0.0	0.0	7.0	7.0	7.0	7.0	15.0

TABLE 20 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Head (Helmet) Breadth	0.0	0.0	0.0	77.0	77.0	77.0	77.0	77.0
Head (Helmet) Length	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0
Head (Helmet)Circumference	0.0	0.0	0.0	212.0	212.0	212.0	212.0	212.0
Heel Breadth	6.0	6.0	6.0	24.0	24.0	24.0	24.0	39.0
Helmet Rim-Top of Head	NA	NA	NA	106.0	106.0	115.0	115.0	104.0
Hip Breadth, Compressed	4.0	10.0	10.0	25.0	57.0	57.0	57.0	69.0
Hip Breadth, Uncompressed	17.0	33.0	33.0	42.0	78.0	78.0	78.0	96.0
Knee Breadth	5.0	57.0	57.0	43.0	80.0	80.0	80.0	88.0
Knee Circumference	7.0	91.0	91.0	129.0	272.0	272.0	272.0	284.0
Knee Depth	9.0	80.0	80.0	69.0	106.0	106.0	106.0	104.0
Knee Height, Midpatella	-2.0	-2.0	-2.0	36.0	36.0	36.0	36.0	39.0
Knee Height, Sitting	4.0	6.0	6.0	42.0	44.0	44.0	44.0	51.0
Lateral Femoral Epicondyle Height	2.0	6.0	6.0	39.0	40.0	40.0	40.0	47.0
Lateral Malleolus Height	3.0	2.0	2.0	50.0	41.0	41.0	41.0	50.0
Menton-Sellion Length	0.0	0.0	0.0	0.0	0.0	9.0	9.0	48.0
Menton-Top of Head	0.0	0.0	0.0	43.0	43.0	54.0	54.0	80.0
Midshoulder Height	2.0	7.0	8.0	39.0	39.0	40.0	46.0	49.0
Midshoulder Height, Sitting	7.0	14.0	17.0	13.0	13.0	22.0	26.0	25.0
Midthigh Breadth	4.0	34.0	34.0	46.0	60.0	60.0	60.0	63.0
Midthigh Circumference	0.0	54.0	54.0	86.0	197.0	197.0	197.0	227.0
Midthigh Depth	4.0	81.0	81.0	66.0	86.0	86.0	86.0	94.0
Midthigh Height	-5.0	0.0	0.0	33.0	35.0	35.0	35.0	39.0
Neck Breadth	0.0	0.0	0.0	34.0	34.0	61.0	61.0	71.0
Neck Circumference	0.0	0.0	0.0	75.0	75.0	152.0	152.0	158.0
Neck Depth	0.0	0.0	0.0	26.0	26.0	47.0	47.0	68.0
Neck Height, Lateral	1.0	6.0	2.0	40.0	39.0	39.0	41.0	46.0

TABLE 20 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Popliteal Height	-25.0	-50.0	-50.0	-15.0	-41.0	-41.0	-41.0	-31.0
Radiale-Stylion Length	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sellion-Back of Head	0.0	0.0	0.0	37.0	37.0	42.0	42.0	78.0
Sellion-Top of Head	0.0	0.0	0.0	41.0	41.0	46.0	46.0	38.0
Shoulder Circumference, Compressed	-15.0	-2.0	19.0	45.0	53.0	116.0	164.0	244.0
Shoulder Circumference, Uncompressed	-5.0	26.0	48.0	73.0	83.0	145.0	188.0	269.0
Sitting Height	-1.0	4.0	4.0	35.0	38.0	48.0	48.0	46.0
Stature	0.0	1.0	2.0	65.0	62.0	68.0	72.0	74.0
Thigh Breadth, Crotch	3.0	22.0	22.0	30.0	46.0	46.0	46.0	47.0
Thigh Circumference, Crotch	4.0	51.0	51.0	84.0	167.0	167.0	167.0	194.0
Thigh Clearance	12.0	36.0	36.0	33.0	54.0	54.0	54.0	61.0
Thigh Depth, Crotch	6.0	84.0	84.0	60.0	79.0	79.0	79.0	86.0
Trochanteric Height	2.0	-3.0	-3.0	35.0	34.0	34.0	34.0	35.0
Vertical Trunk Circumference (ASCC)	33.0	119.0	106.0	115.0	20.0	229.0	264.0	283.0
Waist Breadth	13.0	38.0	57.0	68.0	80.0	97.0	105.0	114.0
Waist Circumference, Omphalion	0.0	87.0	182.0	214.0	275.0	315.0	413.0	409.0
Waist Depth	44.0	48.0	69.0	90.0	103.0	115.0	136.0	151.0
Waist Height, Omphalion	-3.0	1.0	-1.0	38.0	35.0	38.0	41.0	39.0
Weight	9.0	17.0	33.0	79.0	100.0	111.0	118.0	171.0
Wrist Breadth	0.0	40.0	40.0	27.0	27.0	15.0	15.0	33.0
Wrist Circumference	0.0	52.0	52.0	90.0	90.0	44.0	44.0	106.0
Wrist Depth	0.0	73.0	73.0	32.0	32.0	18.0	18.0	36.0

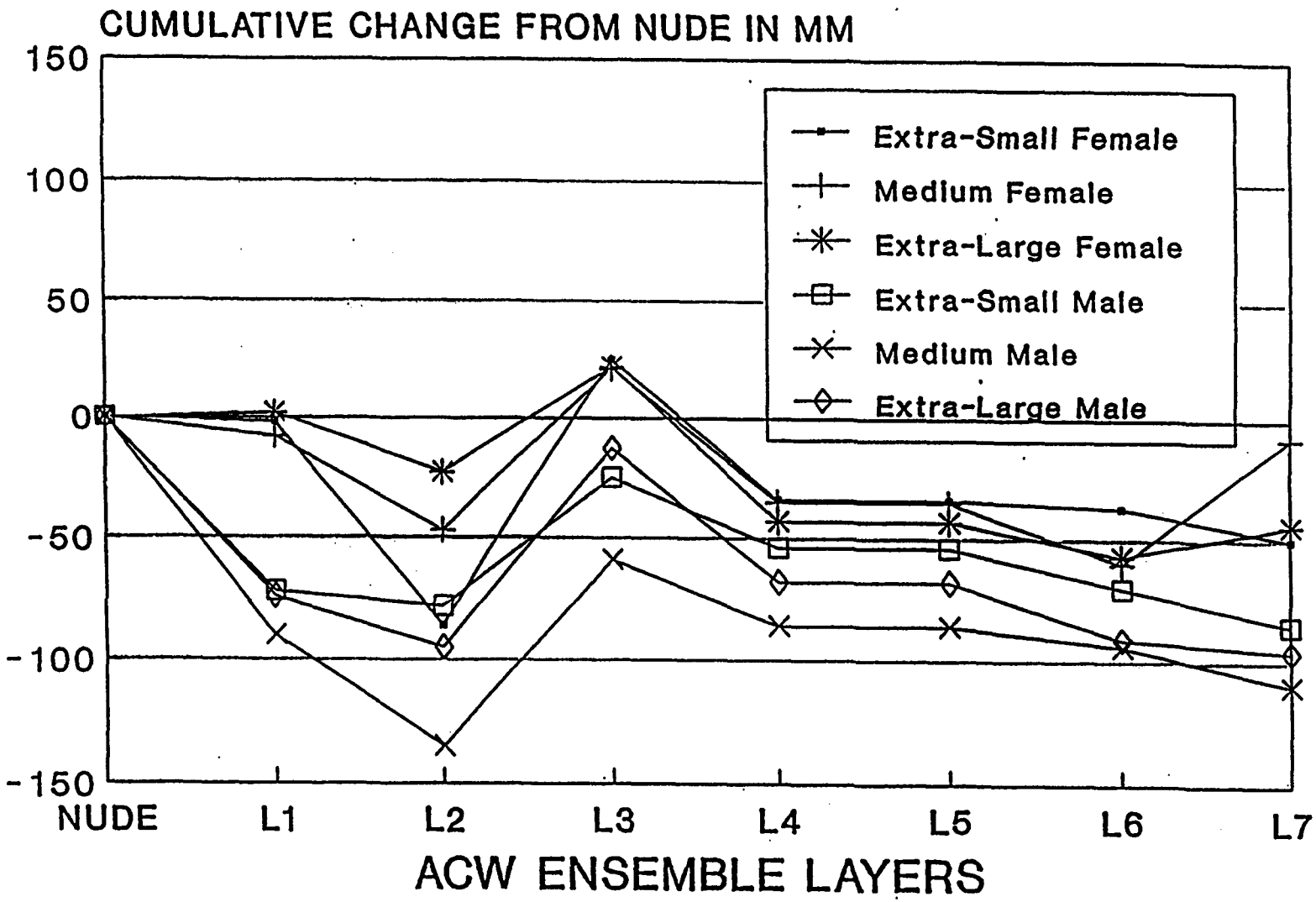

FIGURE 1

Changes in Crotch Height between Nude and ACW Conditions

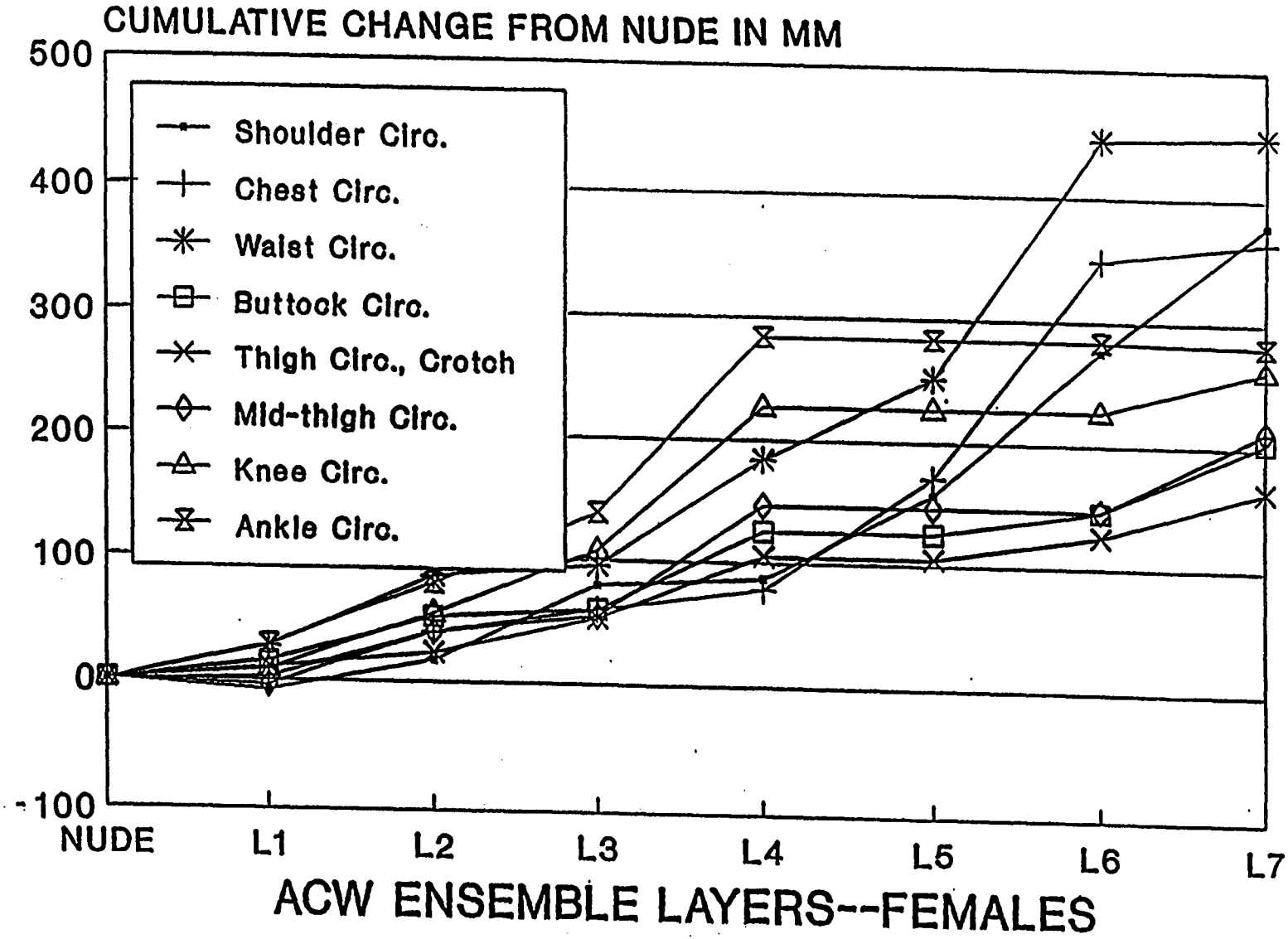

FIGURE 2

Changes in Female Torso and Leg Circumferences between Nude and ACW Conditions

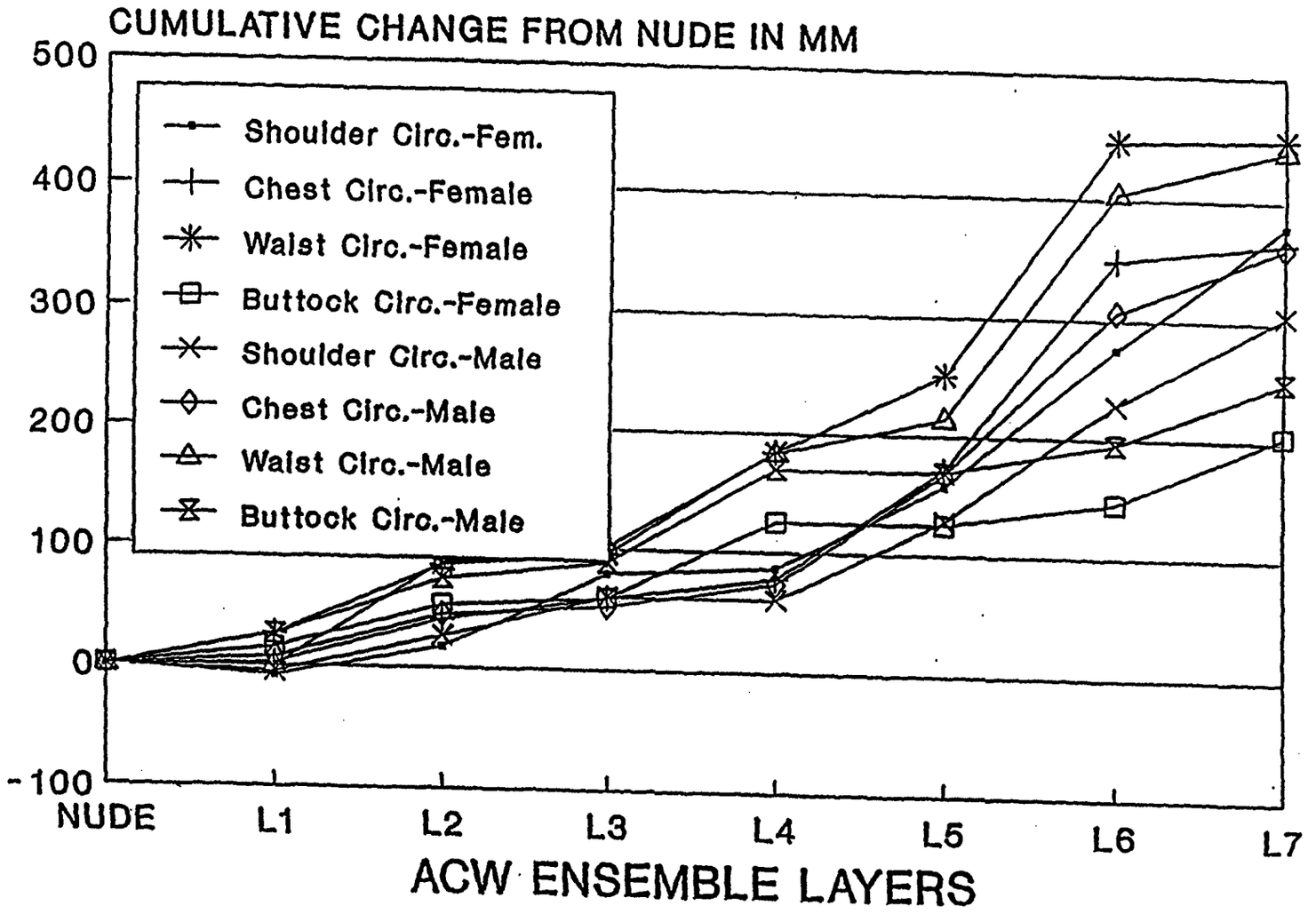

FIGURE 3

Changes in Male and Female Torso Circumferences between Nude and ACW Conditions

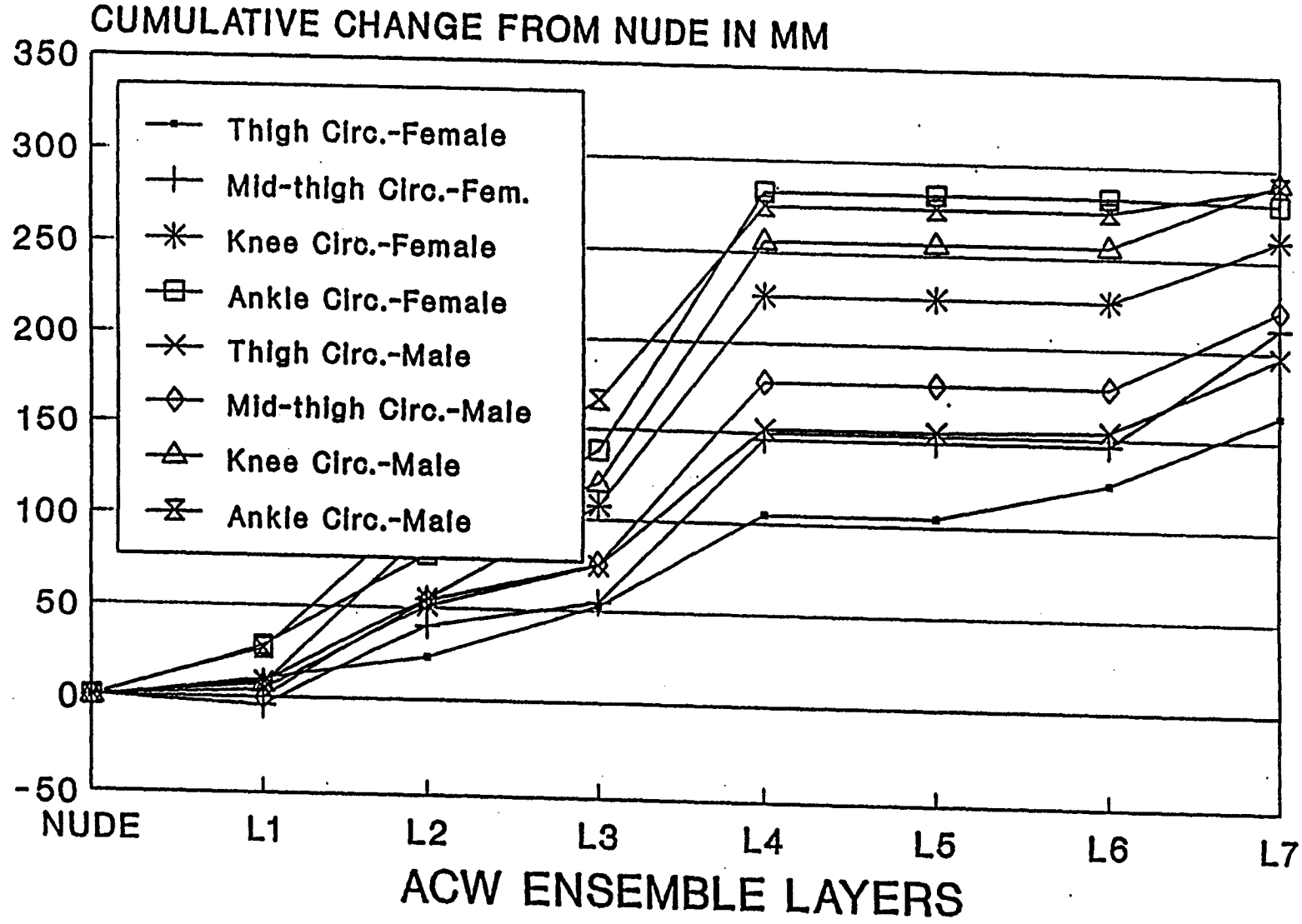

FIGURE 4

Changes in Male and Female Leg Circumferences between Nude and ACW Conditions

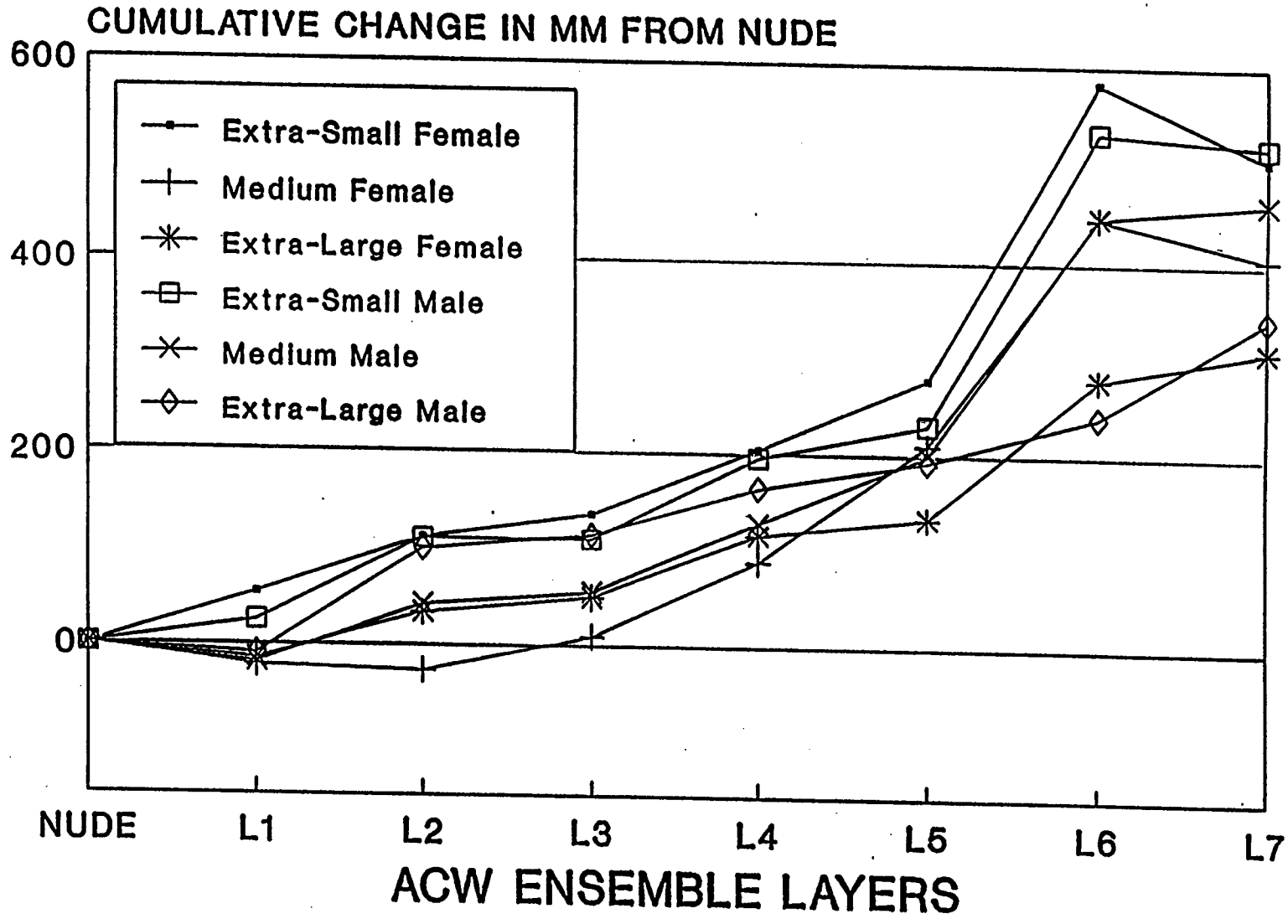

FIGURE 5

Changes in Waist Circumference between Nude and ACW Conditions

The data show clearly that incremental increases in body size can be significant for a number of dimensions in the full-up condition for each of the five ensembles tested. Percentage changes from the nude to these "worst-case" configurations were computed for the different classes of dimensions using grand mean data for the male and female subjects. The data for the circumferences are given in Table 21. As has been noted, the largest percentage change occurred on the limbs, particularly in the more distal portions. Ankle Circumference increased over 100 percent in all cases.

TABLE 21

PERCENTAGE INCREASE IN CIRCUMFERENCES FROM NUDE TO THE WORST CASE LAYER

CIRCUMFERENCE	GS		AWW		ACW		CVCWW	CVCCW
	♂	♀	♂	♀	♂	♀	♂	♂
Ankle Circumference	203	207	104	208	133	138	104	131
Ball of Foot Circumference	44	48	44	48	44	48	44	44
Bicep Circumference	36	52	43	53	55	79	36	54
Buttock Circumference	20	13	18	12	25	21	15	23
Calf Circumference	32	38	32	27	58	66	34	56
Chest Circumference	25	25	30	32	37	41	26	31
Elbow Circumference	60	81	67	79	77	101	51	77
Forearm Circumference	35	58	42	61	50	77	32	47
Hand Circumference	11	11	11	11	11	11	11	11
Head Circumference	35	36	49	56	49	56	37	37
Knee Circumference	45	37	44	31	78	72	45	75
Midthigh Circumference	17	17	18	15	40	39	18	41
Neck Circumference	42	66	41	56	49	74	39	42
Shoulder Circumference	13	18	17	26	26	37	14	23
Thigh Circumference	18	15	15	9	33	27	12	33
Vertical Trunk Circumference	13	11	13	15	19	19	12	17
Waist Circumference	36	41	44	48	50	55	39	47
Wrist Circumference	57	76	60	82	66	91	67	63

Depths and breadths associated with circumferences ranged more widely, with the breadth increments typically the greater. Values approaching 300 percent increase over nude were found for breadth at the ankle. On the limbs, breadth increase was typically greater than for depth; on the torso the pattern was reversed. Worst-case increments for heights were usually less than for the other measurement categories, up to a maximum of approximately 10%. The drops in Axilla Height and Crotch Height were small, but probably significant from a design standpoint.

Perhaps the most useful findings in the study are related to the effect of clothing on body dimensions associated with workspaces, since changes in body size associated with these dimensions can be directly applied to workspace design. Figures 6 through 10 plot worst-case changes in selected workspace dimensions produced by three of the five test ensembles.

Examination of all five figures shows a remarkable degree of similarity in magnitude and pattern of differences. Two conclusions are apparent: 1) the effect of sex and/or body size on the amount of change is minimal; and 2) the magnitude of change follows similar patterns for individuals. For seated workspace design applications, for example, the data are consistant enough to suggest that an additional 50 millimeters or 2 inches are needed for headroom and desk/console height from the floor if cold weather ensembles are to be used. Similarly, if the worst-case ensemble in the workspace is likely to be the GS (with CD), then an increment of 40 millimeters or 1.5 inches may suffice.

The data for the two negative-change dimensions, Buttock-Popliteal Length and Popliteal Height, are somewhat more variable than the other dimensions and perhaps influenced by gender. The utility of these dimensions in designing for clothed individuals is questionable, since the compression of the layers by body weight on the seated surface is largely unknown.

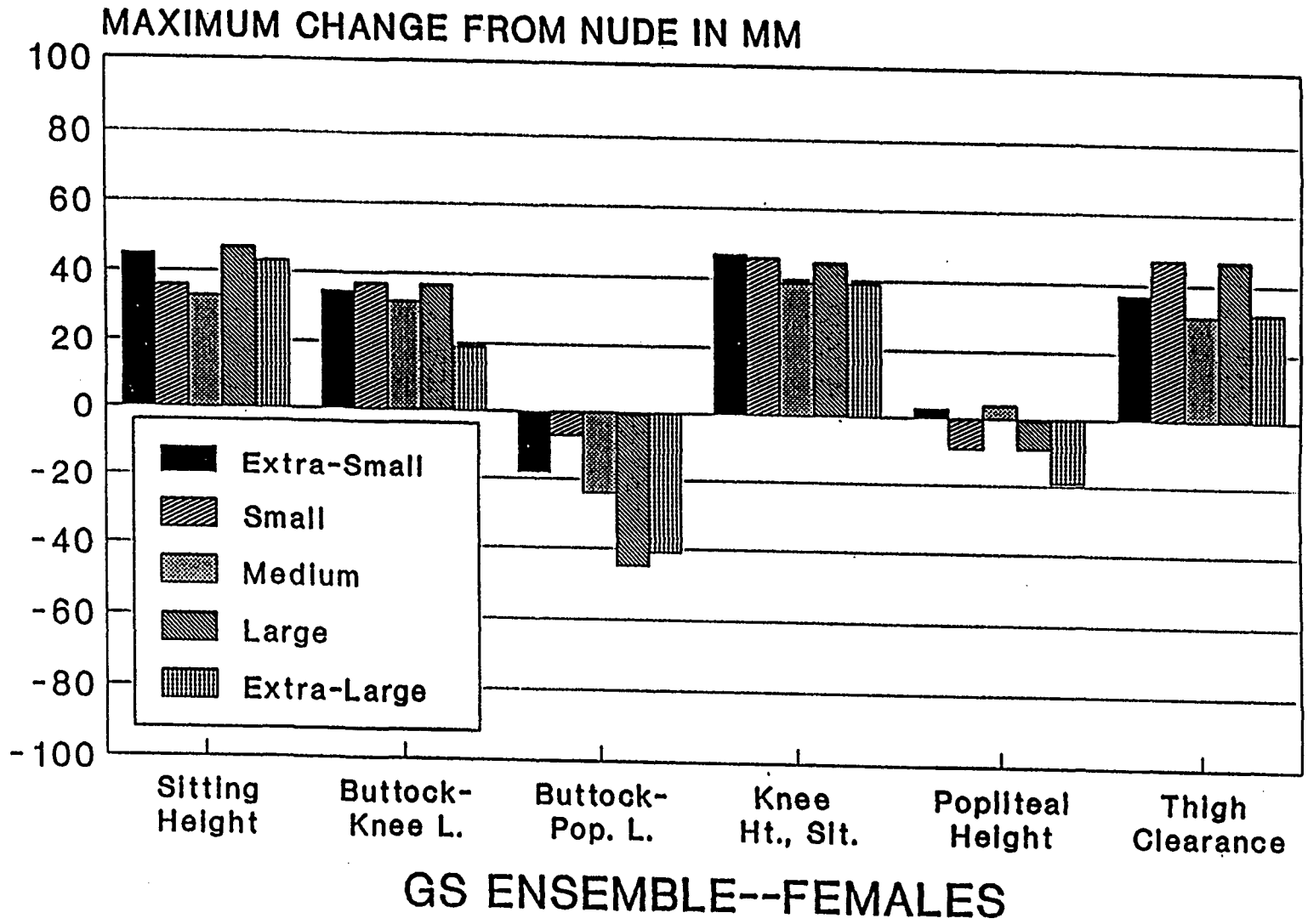

FIGURE 6

Maximum Changes of Selected Workspace Dimensions for Female Subjects: GS Ensemble

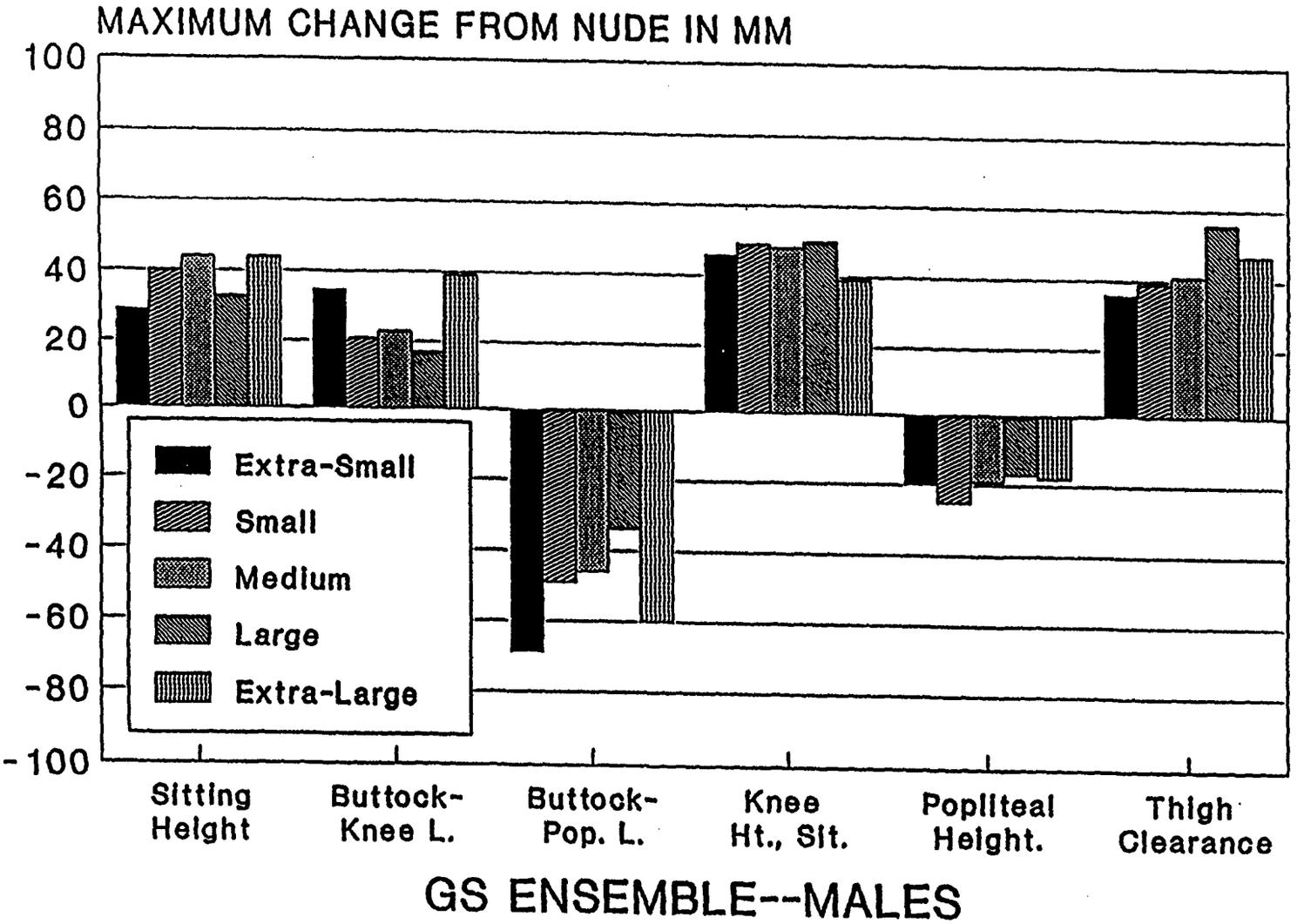

FIGURE 7

Maximum Changes of Selected Workspace Dimensions for Male Subjects: GS Ensemble

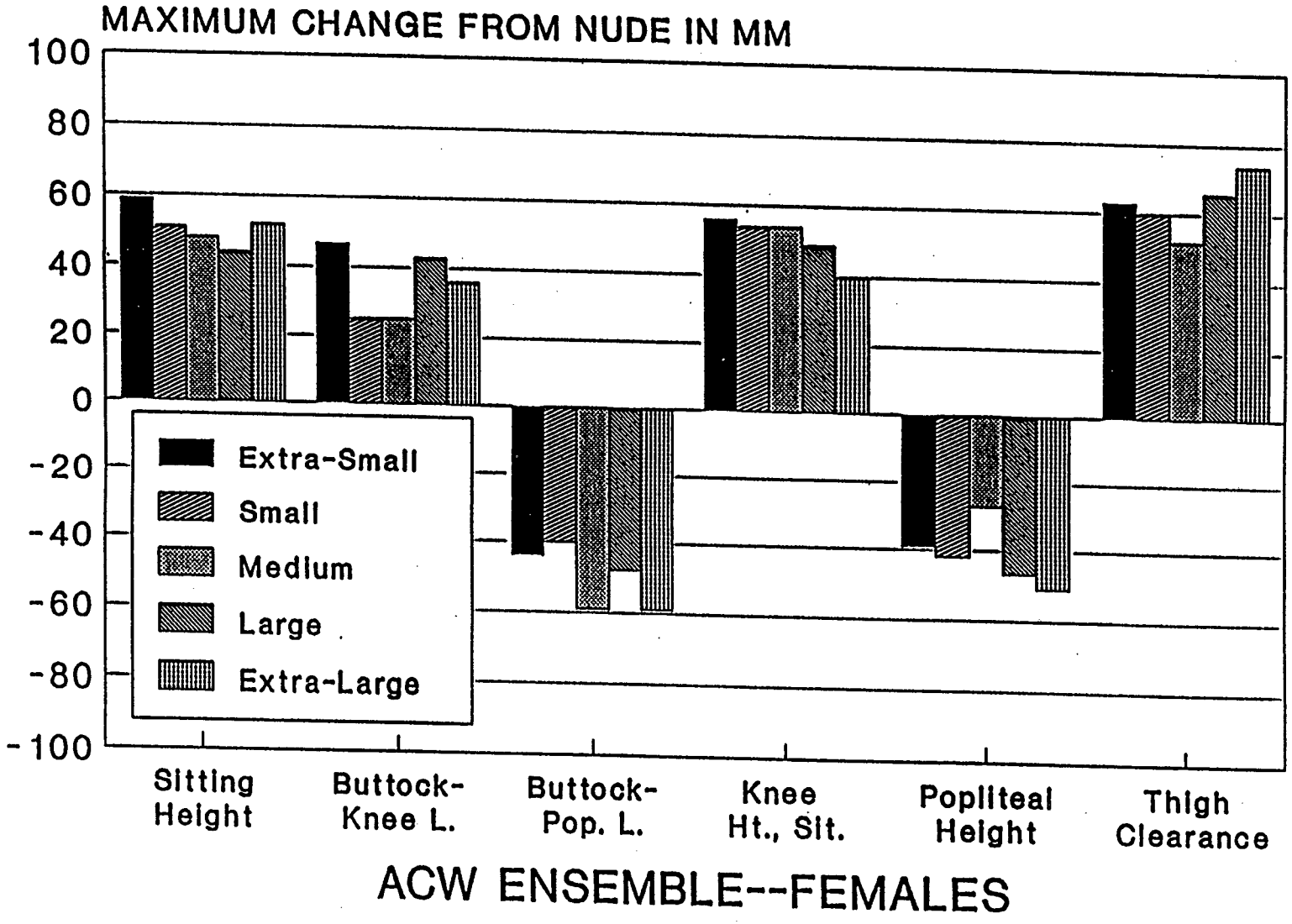

FIGURE 8

Maximum Changes of Selected Workspace Dimensions for Female Subjects: ACW Ensemble

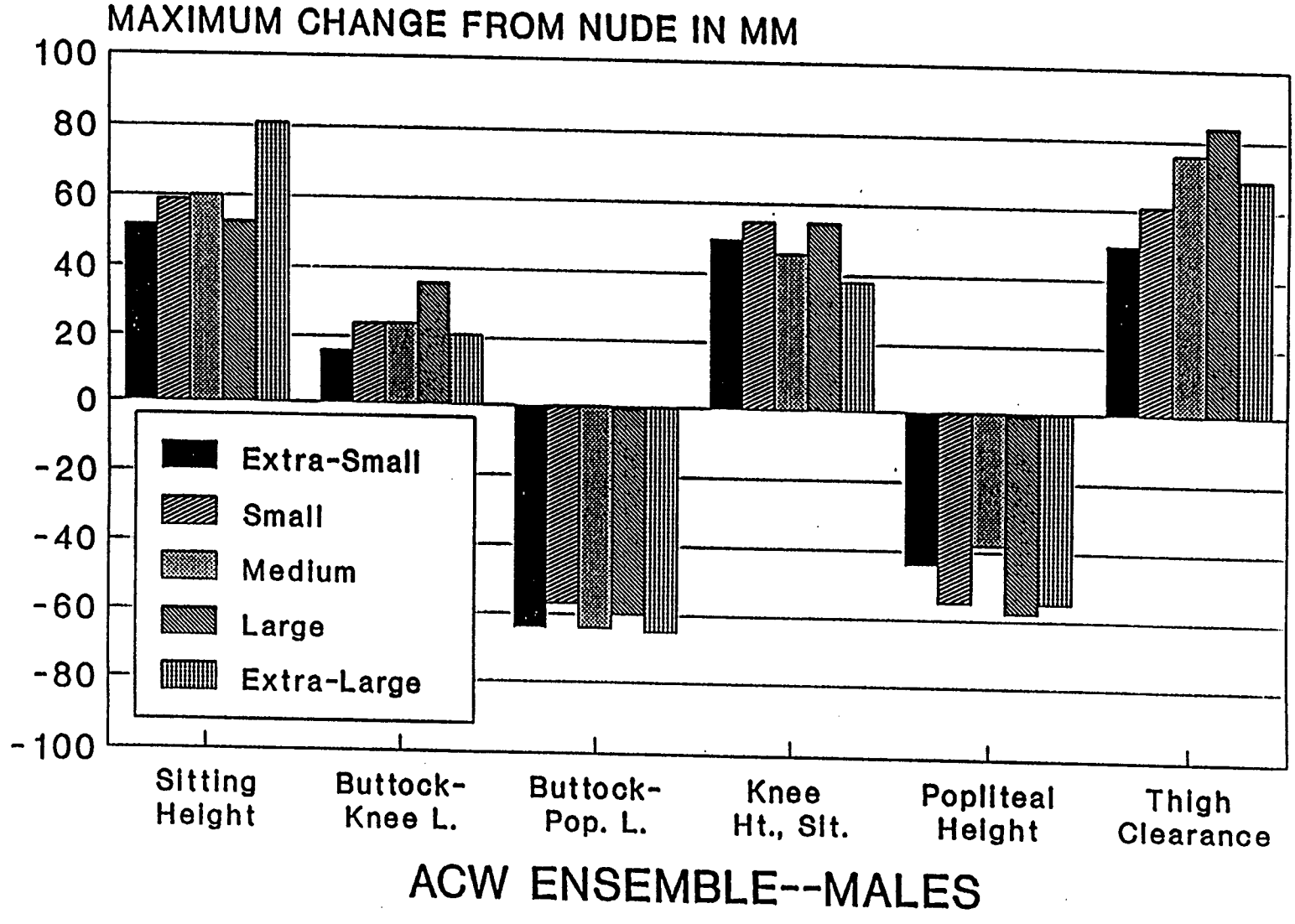

FIGURE 9

Maximum Changes of Selected Workspace Dimensions for Male Subjects: ACW Ensemble

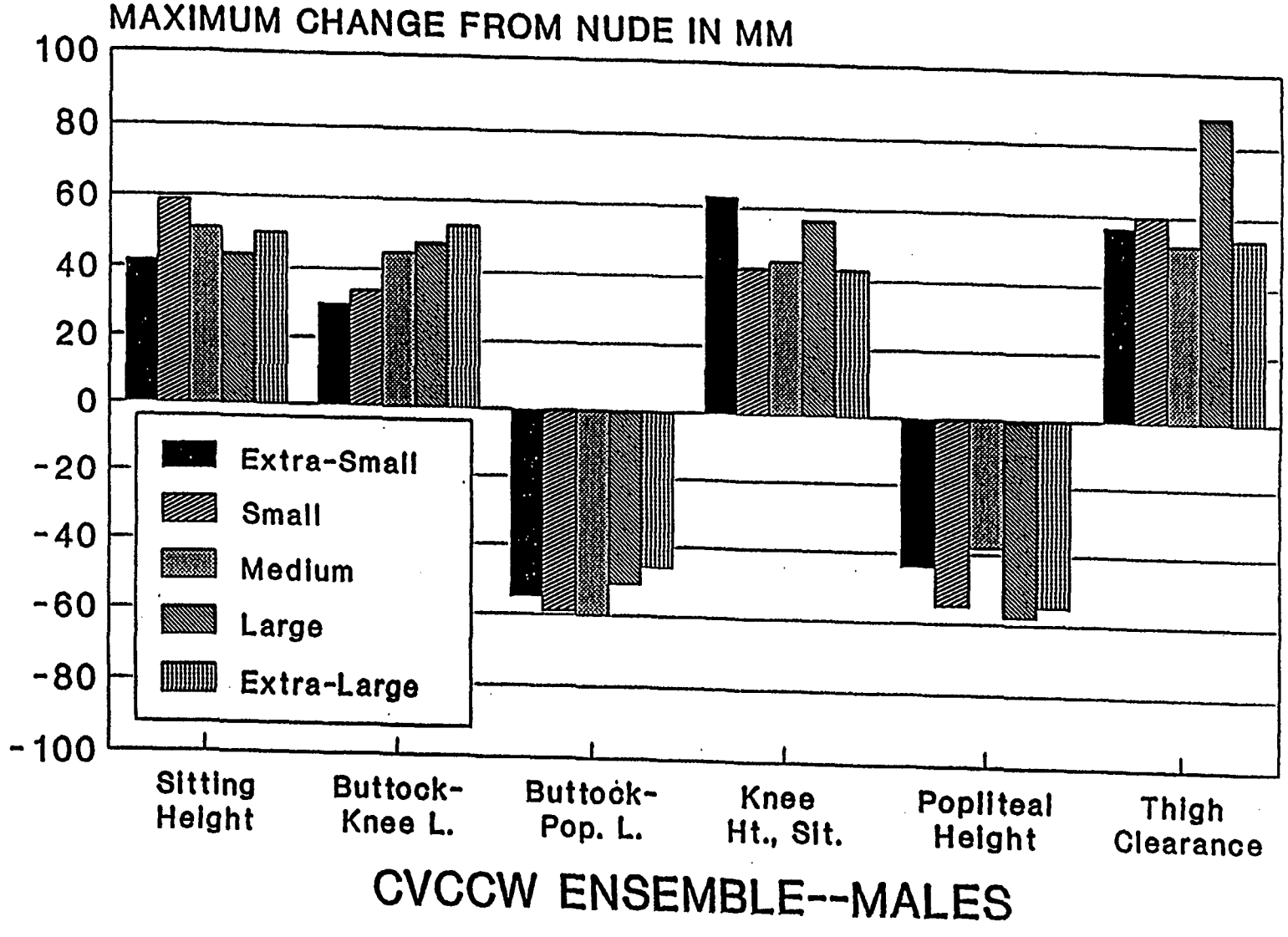

FIGURE 10

Maximum Changes of Selected Workspace Dimensions for Male Subjects: CVCCW Ensemble

CHAPTER 6

DISCUSSION AND RECOMMENDATIONS

LANDMARKING

Using height measurements to establish the levels for measuring CA depths, breadths, and circumferences worked well, and is recommended for future clothed anthropometric studies. With practice it can be done rapidly. In most cases, the heights of clothed anthropometric landmarks can be placed within a centimeter of the nude landmarks, a degree of variability that is probably acceptable for clothed anthropometry.

During the early stages of this study we experimented with other procedures for locating landmarks. Palpation of the bony landmarks was one method that was considered, and was useful through light clothing for some points. Only a few landmarks can be palpated when heavy clothing is worn. Location of a nude landmark through heavy clothing generally requires that a ballbearing be taped over it so it can be felt. This process is time-consuming and is useful for only a few dimensions. An alternate approach examined, was the use of small magnets to demarcate the landmark on the skin. These could then be located through the clothing using a precision magnetometer. This process was also quite slow.

Visual location of the landmarks is generally unreliable when the subject is wearing bulky clothing, since the clothing hides most of the body's curves and distorts the observer's sense of body proportions. If visual cues alone had been utilized, the chest, waist, hips, and knees in most of the clothed subjects would have been located several centimeters below their nude locations. The landmarking methods that were used for each dimension are discussed under the landmark definitions (Appendix D).

SOURCES OF ERROR

Overall, greater random error is expected for clothed measurements than for nude ones. Greater unreliability of the clothed measuring techniques, shifts in the clothing, and the variable manner in which clothing can be donned all contribute to this error. Many smaller dimensions, such as depths, breadths, and circumferences of the arms and legs, often show proportionately greater error than the larger dimensions of the torso. The sample sizes in this study are too small to establish the expected error for each dimension, so it is unclear whether errors for the smaller dimensions are within acceptable limits to permit meaningful analyses of the data.

It is likely that garments fitting poorly on some of the subjects have affected the replication measurements as well as the magnitude of the differences between clothing layers. Improvement of the data collection process, especially for the arm and leg measurements, would undoubtedly result if all subjects were wearing clothing that fit properly. However, many of the garments used in this study have not been specifically developed and sized to fit small females. In addition, garments such as CPO are available in only five sizes.

Measuring error can be reduced by using a data entry editing program that will spot inconsistencies in the data and allow corrections to be made before the subject leaves. This procedure helps eliminate many of the spurious measurements, and improves the overall measuring reliability. Larger samples than those used in the present study would be necessary to set up valid editing routines.

The measurement errors for nude and clothed anthropometry are often greater than the differences one would expect to see between some layers of clothing. In other words, the fine differences between some layers cannot be realistically measured, especially when the measurements are made over a period of several hours or several days. The authors recommend that in any future CA survey, subjects should be measured only in clothing conditions that would actually be worn in various work or combat situations.

FUTURE SURVEY DESIGN

The present investigation was devised and conducted as a pilot study to explore measurement techniques that would document the effects of complex, multilayered ensembles on the body size of soldiers. If a large-scale clothed survey is ever planned or conducted, traditional anthropometry methods should probably be used. However, if a breakthrough in automated anthropometry occurs, serious consideration should be given to adopting the newer method, since clothed measurements are very time consuming. A full body laser scanner system, for example, would be able to provide a true 3-D picture of the body surface or outermost garment surface of an individual soldier in just a few seconds. Data reduction could be completed later. Existing software permits rapid derivation of point-to-point distances, complex contour lengths and circumferences, and high-density digitized data to describe shape. The advantages of rapid, remote data collection are obvious. Scans of an individual soldier wearing a variety of layers making up several ensembles could be completed almost as fast as he/she could don the clothing.

In the more likely event that traditional anthropometry would be the method of choice in the foreseeable future, the following recommendations are made:

1. The methods should follow those developed for the ANSUR survey and used in the current project for the vast majority of the measurements. This will allow direct comparison to a well-established database.

2. The total number of measurements made for each condition should be limited to considerably less than the 100 or so made in this study. The dimensions should fall into four major applied categories: general body size descriptors; computer man/woman modelling; workspace design; and, clothing sizing and design. The general body size descriptors are used to permit comparisons of the sample with the ANSUR database and would need to be completed only in the nude condition. Computer model dimensions should include a variety of circumferences, depths, and breadths principally on the torso. Workspace dimensions should be limited to 8 or 10

critical dimensions such as Sitting Height, Buttock-Knee Length, Buttock-Popliteal Length, Popliteal Height, Knee Height-Sitting, Thigh Clearance, and maximum depth and breadth at the shoulders and the hips.

To keep the total number of measurements down, priority should be given to dimensions which serve more than one of these applications. Circumferences, depth, and breadth measurements over loose-fitting garments should be avoided, especially on the limbs, since these measurements are highly variable and difficult to interpret.

It would also be useful to obtain length and breadth data on individual garments stretched on a flat surface. Such measurements would be especially useful over the arm and leg areas of the garments.

3. Data trade-offs for different sampling approaches should be examined. For example, all subjects should be measured for all of the selected nude dimensions, but should

   -- they all be measured in multiple ensembles?
   -- they all be measured in all ensembles?
   -- they all be measured in all layers of any given ensemble?
   -- any of them be expected to devote several days to the measurements?

4. Traditional measurements and ROJM measurements should be coordinated and run on the same subjects with a minimum time delay. To some extent, the nature of the anthropometry to be performed on a large sample will depend on whether the survey is conducted in conjunction with an ROJM study.

5. Individual soldiers should be measured in their personal issue where possible. Any custom tailoring in the clothing should be noted. For non-issue items, a soldier should be fit-tested prior to the measurements and measured in the best available size. Subjects should only be measured in ensembles used in their occupational specialty.

6. Measurements should only be made in functional uniform configurations. That is, measurements need not be taken over layers which are never used as the outside garment in a work or combat situation.

7. On-line computer entry and editing based upon the pilot study and ANSUR data should be used.

This document reports research undertaken at the U.S. Army Soldier and Biological Chemical Command, Soldier Systems Center, and has been assigned No. NATICK/TR-99/012 in a series of reports approved for publication.

REFERENCES

Alexander, M., J.W. Garrett, and M.P. Flannery. 1969. Anthropometric Dimensions of Air Force Pressure-Suited Personnel for Workspace and Design Criteria. Technical Report AMRL-TR-69-6 (AD 697 022). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH.

Alexander, M., J.W. Garrett, and J.C. Robinette. 1970. Anthropological Applications in High Altitude Flight Systems. Technical Report AMRL-TR-70-3 (AD 706 888). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH.

Alexander, M., J.T. McConville, J.H. Kramer and E. Fritz. 1964. Height-Weight Sizing of Protective Garments, Based on Japanese Air Self-Defense Force Pilot Data with Fit-Test Results. Technical Report AMRL-TR-64-66 (AD 606 039). Aerospace Medical Research Laboratory, Wright Patterson Air Force Base, OH.

Churchill, E., T. Churchill, J.T. McConville and R.M. White. 1977. Anthropometry of Women of the U.S. Army - 1977; Report No. 2 - The Basic Univariate Statistics. Technical Report NATICK/TR-77/024 (AD A044 806). U.S. Army Natick Research and Development Command, Natick, MA.

Clauser, C.E., I.O. Tebbetts, B. Bradtmiller, J.T. McConville, and C.C. Gordon. 1988. Measurer's Handbook: U.S. Army Anthropometric Survey, 1987-1988. Technical Report Natick/TR-88/043. U.S. Army Natick Research, Development and Engineering Center, Natick, MA.

Clauser, C.E., P.E. Tucker, J.T. McConville, E. Churchill, L. Laubach and J. Reardon. 1972. Anthropometry of Air Force Women. Technical Report AMRL-TR-70-5 (AD 743 113). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH.

Daziens, P., B. Bradtmiller and S. Upchurch. 1989. Clothed Anthropometry of Crew Chief. Appendix A in Gibbons, L.E.(editor) Summary of Ergonomics Research for the Crew Cheif Model Development. AAMRL-TR-90-038. Armstrong Aerospace Medical Research Laboratory, Air Force Human Resources Laboratory, Human Systems Division, Air Force Systems Command, Wright-Patterson Air Force Base, OH.

Garrett, J.W. 1968. Clearance and Performance Values of the Bare-Handed and Pressure- Gloved Operator. Technical Report AMRL-TR-68-24 (AD 681 457). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH.

Gordon, C.C., B. Bradtmiller, T. Churchill, C.E. Clauser, J.T. McConville, I.O. Tebbetts, and R. Walker. 1989. 1988 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics. Technical Report NATICK/TR-89/044. U.S. Army Natick Research, Development and Engineering Center, Natick, MA.

Hertzberg, H.T.E., E. Churchill, C.W. Dupertuis, R.M. White and A. Damon. 1963. Anthropometric Survey of Turkey, Greece and Italy. MacMillan Company, New York.

Hooton, E.A. 1945. A Survey in Seating. Greenwood Press Publishers, Westport, Connecticut.

Johnson, R.F. 1984. Anthropometry of the Clothed U.S. Army Ground Troop and Combat Vehicle Crewman. Technical Report NATICK/TR-84/034. U.S. Army Natick Research and Development Center, Natick, MA.

Khandkar, S.M., G.A.H. MacDonald, D. Beevis, I. Noy. 1980. Clothed Anthropometry in the Canadian Forces Using Direct and Photogrammetric Methods. Technical Report 81-R-04 (AD B06 1606). Defence and Civil Institute of Environmental Medicine, Downsview, Ontario, M3M 3B9.

Kobrick, J.L. 1956a. Quartermaster Human Engineering Handbook Series: I. Spatial Dimensions of the 95th Percentile Arctic Soldier. Environmental Protection Research Division Technical Report EP-39. U.S. Army Quartermaster Research and Development Center, Natick, MA.

Kobrick, J.L. 1956b. Quartermaster Human Engineering Handbook Series: II. Dimensions of the Upper Limit of Gloved Hand Size. Environmental Protection Research Division Technical Report EP-41. U.S. Army Quartermaster Research and Development Center, Natick, MA.

Kobrick, J.L. 1957a. Quartermaster Human Engineering Handbook Series: III. Dimensions of the Lower Limit of Gloved Hand Size. Environmental Protection Research Division Technical Report EP-43. U.S. Army Quartermaster Research and Development Center, Natick, MA.

Kobrick, J.L. 1957b. Quartermaster Human Engineering Handbook Series: IV. Dimensions of the Lower Limit of the Body Size of the Arctic Soldier. Environmental Protection Research Division Technical Report EP-51. U.S. Army Quartermaster Research and Development Center, Natick, MA.

Kobrick, J.L., and B. Crist. 1960. Quartermaster Human Engineering Handbook Series: VII. The Size and Shape of the Available Visual Field During the Wearing of Army Headgear. Environmental Protection Research Division Technical Report EP-133. U.S. Army Quartermaster Research and Engineering Center, Natick, MA.

Middleton, R.H., M. Alexander and K.W. Gillespie. 1970. Cockpit Compatibility Studies Conducted with Aircrew Members Wearing High Alititude Flying Outfits in B-57D, B-57F, F-104B, and F-106B Aircraft. Technical Report ASD-TR-70-25 (AD 880 672). Aeronautical Systems Division, Wright-Patterson Air Force Base, OH.

Paquette, S.P., R.A. Maulucci and R.H. Eckhouse, Jr.. (in press). The Effects of Multilayered Military Ensembles on Range of Joint Motion: A Pilot Study. U.S. Army Natick Research, Development and Engineering Center, Soldier Science Directorate, Natick, MA.

Randall, F.E., A. Damon, R.S. Benton, and D.I. Patt. 1946. Human Body Size in Military Aircraft and Personal Equipment. Technical Report AAF-TR-5501 (ATI 25 419). Air Materiel Command, Wright Field, Dayton, OH.

Roberts, L.B. 1945. Size Increase of Men Wearing Various Clothing Combinations. Project No. 9, SPMEA 741-3, Armored Medical Research Laboratory, Fort Knox, KY.

Webb, P. 1964. Bioastronautics Data Book, NASA Sp-3006, National Aeronautics and Space Administration, Washington D.C.

White, R.M., J.L. Kobrick, T.R. Zimmerer. 1964. Reference Anthropometry of the Arctic-Equipped Soldier. Technical Report EPT-2. U.S. Army Natick Laboratories, Pioneering Research Division, Natick, MA.

APPENDIX A

CLOTHING ENSEMBLES

TABLE A-1

GROUND SOLDIER ENSEMBLE LAYERS

LAYER 1	t-shirt, socks
LAYER 2 (plus all of above)	BDU coat + trousers, combat boots, ground soldier helmet
LAYER 3 (plus all of above)	CP glove liner, CP gloves, CP coat + trouser, M40 mask + hood, GVO boots
LAYER 4 (plus all of above)	PASGT vest

Ground Soldier Ensemble

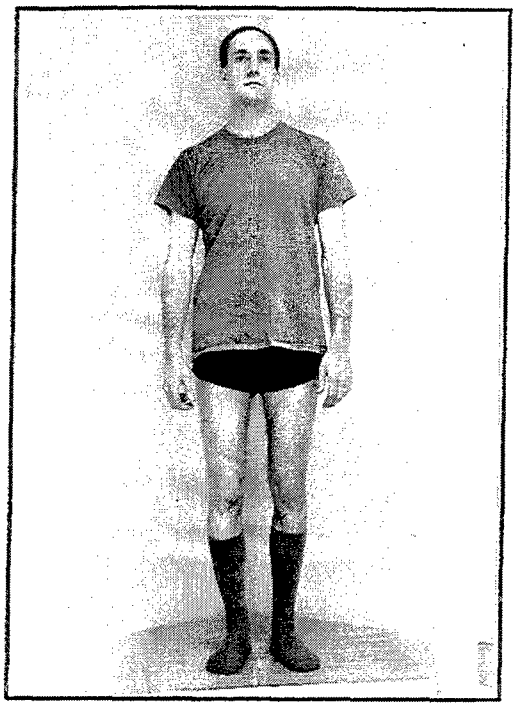

FIGURE A-1

Layer 1
T-Shirt and Socks

FIGURE A-2

Layer 2
BDU Coat and Trousers

FIGURE A-3

Layer 3
Chemical Protective Overgarment

FIGURE A-4

Layer 4
PASGT Vest

TABLE A-2

AVIATOR WARM WEATHER ENSEMBLE LAYERS

LAYER 1	t-shirt, socks
LAYER 2 (plus all of above)	aviator coveralls, combat boots, aviator helmet, aviator gloves
LAYER 3 (plus all of above)	warm weather jacket
LAYER 4 (plus all of above)	SARVIP with insert
LAYER 5 (plus all of above)	CP glove liner, CP gloves, CP coat + trouser, M40 mask + hood, GVO boots

Aviator Warm Weather Ensemble

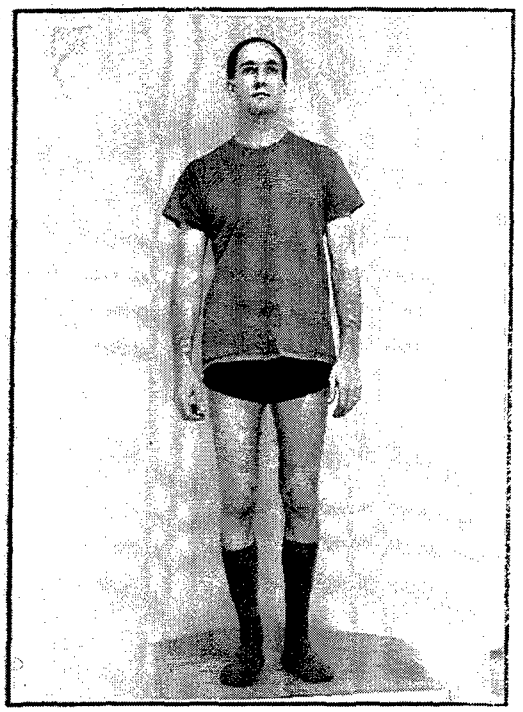

FIGURE A-5

Layer 1
T-Shirt and Socks

FIGURE A-6

Layer 2
Aviator Coveralls

FIGURE A-7

Layer 3
Warm Weather Jacket

FIGURE A-8

Layer 4
SARVIP with Insert

FIGURE A-9

Layer 5
Chemical Protective Overgarment

TABLE A-3

AVIATOR COLD WEATHER ENSEMBLE LAYERS

LAYER 1	t-shirt, long-johns, socks
LAYER 2 (plus all of above)	quilted batting liner
LAYER 3 (plus all of above)	aviator coveralls, combat boots, aviator helmet, aviator gloves
LAYER 4 (plus all of above)	overalls
LAYER 5 (plus all of above)	cold weather jacket
LAYER 6 (plus all of above)	SARVIP with insert
LAYER 7 (plus all of above)	CP glove liner, CP gloves, CP coat + trouser, M40 mask + hood, GVO boots

Aviator Cold Weather Ensemble

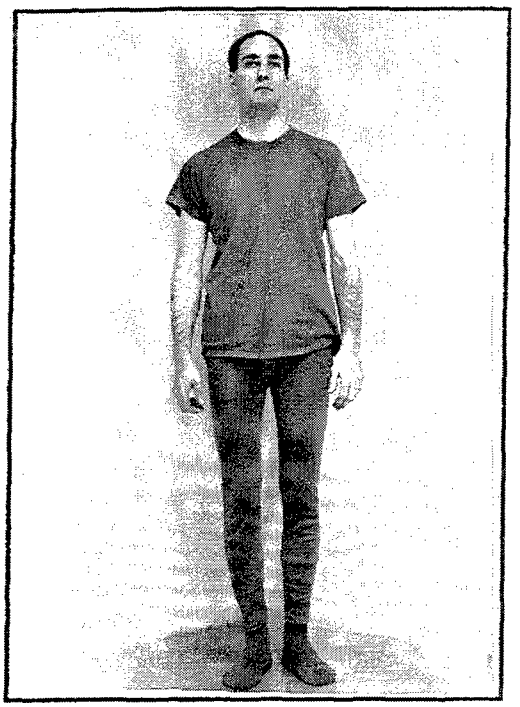

FIGURE A-10

Layer 1
Cotton-Wool Long Johns

FIGURE A-11

Layer 2
Quilted Batting Liner

FIGURE A-12

Layer 3
Aviator Coveralls

FIGURE A-13

Layer 4
Bib Overalls

FIGURE A-14

Layer 5
Cold Weather Jacket

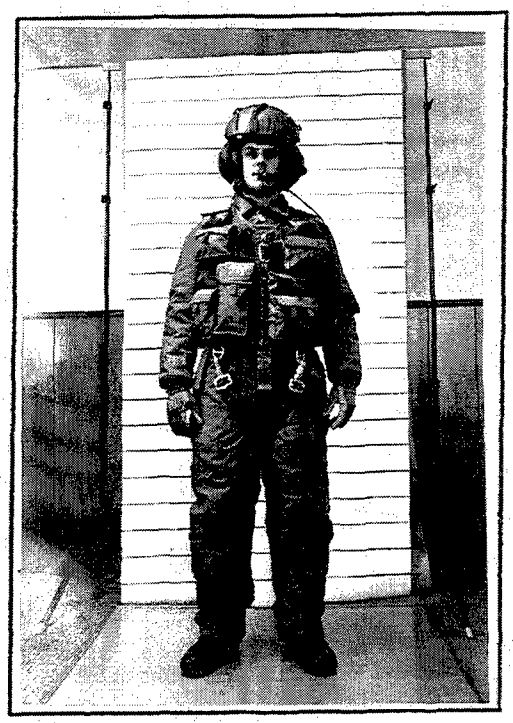

FIGURE A-15

Layer 6
SARVIP with Insert

FIGURE A-16

Layer 7
Chemical Protective Overgarment

TABLE A-4

COMBAT VEHICLE CREWMAN (CVC) WARM WEATHER ENSEMBLE LAYERS

LAYER 1	t-shirt, socks
LAYER 2 (plus all of above)	cooling vest
LAYER 3 (plus all of above)	ballistic vest
LAYER 4 (plus all of above)	CVC coveralls, combat boots, CVC helmet, CVC gloves
LAYER 5 (plus all of above)	survival vest
LAYER 6 (plus all of above)	CP coat + trouser, M40 mask + hood, CP glove liners, CP gloves, GVO boots

CVC Warm Weather Ensemble

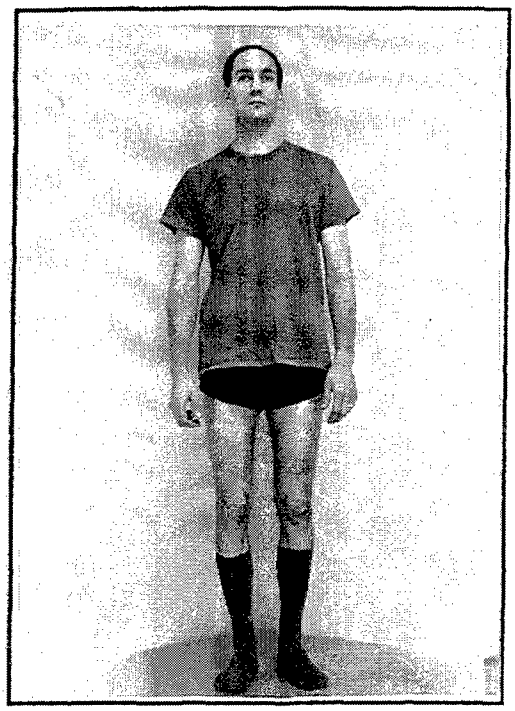

FIGURE A-17

Layer 1
T-Shirt and Socks

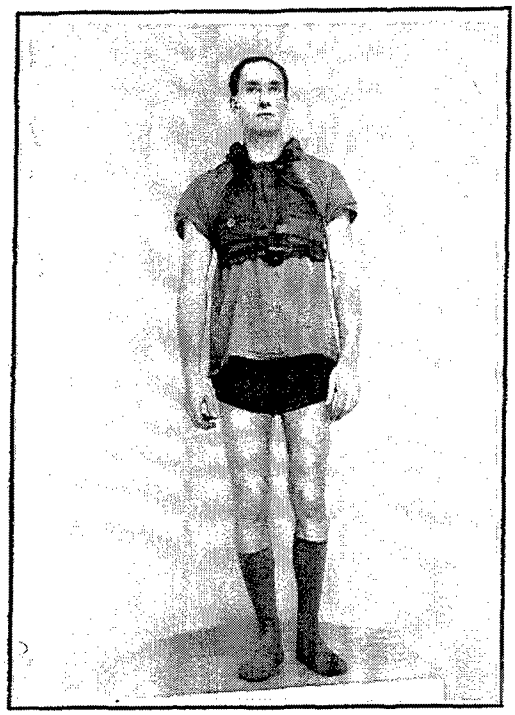

FIGURE A-18

Layer 2
Cooling Vest

FIGURE A-19

Layer 3
Ballistic Vest

FIGURE A-20

Layer 4
CVC Coveralls

FIGURE A-21

Layer 5
Survival Vest

FIGURE A-22

Layer 6
Chemical Protective Overgarment

TABLE A-5

COMBAT VEHICLE CREWMAN (CVC) COLD WEATHER ENSEMBLE LAYERS

LAYER 1	t-shirt, long-johns, socks
LAYER 2 (plus all of above)	quilted batting liner
LAYER 3 (plus all of above)	ballistic vest
LAYER 4 (plus all of above)	CVC coveralls, combat boots, CVC helmet, CVC gloves
LAYER 5 (plus all of above)	overalls
LAYER 6 (plus all of above)	cold weather jacket, balaclava
LAYER 7 (plus all of above)	survival vest
LAYER 8 (plus all of above)	CP coat + trouser, M40 mask + hood, CP glove liners, CP gloves, GVO Boots

CVC Cold Weather Ensemble

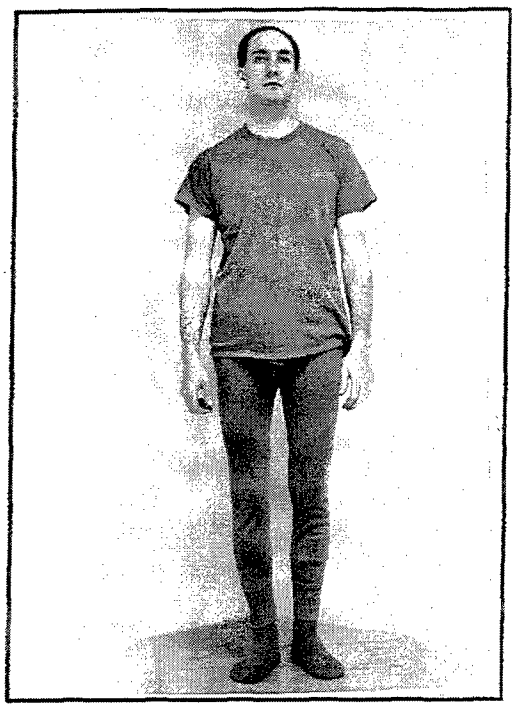

FIGURE A-23

Layer 1
Cotton-Wool Long Johns

FIGURE A-24

Layer 2
Quilted Batting Liner

FIGURE A-25

Layer 3
Ballistic Vest

FIGURE A-26

Layer 4
CVC Coveralls

FIGURE A-27

Layer 5
Bib Overalls

FIGURE A-28

Layer 6
Cold Weather Jacket and Balaclava

FIGURE A-29

Layer 7
Survival Vest

FIGURE A-30

Layer 8
Chemical Protective Overgarment

APPENDIX B

CLOTHING SIZES WORN BY EACH SUBJECT AND MEASURERS' FIT COMMENTS

TABLE B-1

GROUND SOLDIER ENSEMBLE
SIZES WORN BY FEMALE SUBJECTS

	x-sm ♀	small ♀	medium ♀	large ♀	x-large ♀
T-shirt	small	small	small	medium	medium
Socks	small	small	medium	medium	medium
BDU Coat	xsm-short	xsm-short	xsm-short	med-short	med-short
BDU Trouser	xsm-short	sm-short	sm-regular	med-short	med-regular
Combat Boot	7 1/2 R	5 1/2 R	7 1/2 R	6 W	10 R
Helmet	small	small	small	small	small
CD Coat	x-small	small	x-small	small	medium
CD Trouser	x-small	small	x-small	small	medium
CD Glove Liner	small	small	medium	small	medium
CD Glove	x-small	x-small	small	x-small	small
GVO	9	7	9	7	11
PASGT Vest	small	small	small	large	large

TABLE B-2

GROUND SOLDIER ENSEMBLE
SIZES WORN BY MALE SUBJECTS

	x-sm ♂	small ♂	medium ♂	large ♂	x-large ♂
T-shirt	small	small	large	large	large
Socks	medium	medium	medium	large	large
BDU Coat	sm-short	sm-short	med-regular	med-regular	xlg-regular
BDU Trouser	sm-xshort	med-short	med-short	med-short	lg-long
Combat Boot	9 1/2 W	8 1/2 W	10 1/2 R	11 1/2 R	10 R
Helmet	small	small	large	large	large
CD Coat	small	small	medium	medium	large
CD Trouser	small	small	medium	medium	large
CD Glove Liner	small	small	medium	medium	medium
CD Glove	small	medium	medium	large	large
GVO	11	10	13	13	11
PASGT Vest	small	large	large	large	x-large

TABLE B-3

AVIATOR WARM WEATHER ENSEMBLE
SIZES WORN BY FEMALE SUBJECTS

	x-sm ♀	small ♀	medium ♀	large ♀	x-large ♀
T-shirt	small	small	small	medium	medium
Socks	small	small	medium	medium	medium
Coveralls	32 regular	34 regular	34 regular	36 regular	40 regular
Gloves	7	7	8	7	7
Combat Boot	7 1/2 R	5 1/2 R	7 1/2 R	6 W	10 R
Helmet	large	large	large	large	large
Lt. Weather Jacket	sm-regular	sm-regular	sm-regular	sm-regular	med-regular
SARVIP	small	small	small	large	large
CD Coat	small	medium	small	medium	large
CD Trouser	x-small	small	x-small	small	medium
CD Glove Liner	small	small	medium	small	medium
CD Glove	x-small	x-small	small	x-small	small
GVO	9	7	9	7	11

TABLE B-4

AVIATOR WARM WEATHER ENSEMBLE
SIZES WORN BY MALE SUBJECTS

	x-sm ♂	small ♂	medium ♂	large ♂	x-large ♂
T-shirt	small	small	large	large	large
Socks	medium	medium	medium	large	large
Coveralls	36 regular	36 regular	38 regular	42 regular	44 regular
Gloves	8	9	10	10	11
Combat Boot	9 1/2 W	8 1/2 W	10 1/2 R	11 1/2 R	10 R
Helmet	large	large	large	large	large
Lt. Weather Jacket	med-regular	sm-regular	med-regular	lg-regular	xlg-regular
SARVIP	large	large	large	large	large
CD Coat	medium	medium	large	large	x-large
CD Trouser	small	small	medium	medium	large
CD Glove Liner	small	medium	medium	medium	medium
CD Glove	small	small	medium	large	large
GVO	11	10	13	13	11

TABLE B-5

AVIATOR COLD WEATHER ENSEMBLE
SIZES WORN BY FEMALE SUBJECTS

	x-sm ♀	small ♀	medium ♀	large ♀	x-large ♀
T-shirt	small	small	small	medium	medium
Long-Johns	small	small	small	small	medium
Socks	small	small	medium	medium	medium
QBL Jacket	sm-short	sm-short	sm-short	sm-short	med-long
QBL Trouser	xsm-short	xsm-short	xsm-short	sm-regular	med-long
Coveralls	32 regular	36 regular	36 regular	38 regular	42 regular
Gloves	7	7	8	7	7
Combat Boot	7 1/2 R	5 1/2 R	7 1/2 R	6 W	10 R
Helmet	large	large	large	large	large
Overalls	sm-short	sm-short	sm-short	sm-short	med-regular
Cold Weather Jacket	sm-short	sm-regular	med-regular	med-regular	med-long
SARVIP	large	small	large	large	large
CD Coat	small	medium	medium	medium	large
CD Trouser	small	small	small	medium	large
CD Glove Liner	small	small	medium	small	medium
CD Glove	x-small	x-small	small	x-small	small
GVO	9	7	9	7	11

TABLE B-6

AVIATOR COLD WEATHER ENSEMBLE
SIZES WORN BY MALE SUBJECTS

	x-sm ♂	small ♂	medium ♂	large ♂	x-large ♂
T-shirt	small	small	large	large	large
Long-Johns	small	small	medium	medium	large
Socks	medium	medium	medium	large	large
QBL Jacket	sm-short	sm-short	med-long	lg-short	xlg-regular
QBL Trouser	xsm-short	xsm-short	med-regular	med-regular	xlg-regular
Coveralls	38 regular	38 regular	40 regular	42 regular	46 regular
Gloves	8	9	10	10	11
Combat Boot	9 1/2 W	8 1/2 W	10 1/2 R	11 1/2 R	10 R
Helmet	large	large	large	large	large
Overalls	med-regular	med-regular	med-regular	lg-long	lg-long
Cold Weather Jacket	med-regular	med-short	large	lg-regular	xlg-regular
SARVIP	large	large	large	large	large
CD Coat	medium	medium	large	x-large	x-large
CD Trouser	medium	small	medium	large	x-large
CD Glove Liner	small	medium	medium	medium	medium
CD Glove	small	small	medium	large	large
GVO	11	10	13	13	11

TABLE B-7

COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
SIZES WORN BY MALE SUBJECTS

	x-sm ♂	small ♂	medium ♂	large ♂	x-large ♂
T-shirt	small	small	large	large	large
Socks	medium	medium	medium	large	large
Cooling Vest	large	large	large	large	large
Ballistic Vest	med-regular	med-regular	lg-regular	lg-long	lg-long
Coveralls	med-short	med-short	med-regular	lg-regular	lg-regular
Gloves	9	10	10	10	10
Combat Boot	9 1/2 W	8 1/2 W	10 1/2 R	11 1/2 R	10 R
Helmet	large	large	large	large	large
Survival Vest	large	large	large	large	large
CD Coat	small	small	medium	large	large
CD Trouser	x-small	small	medium	medium	medium
CD Glove Liner	small	small	medium	medium	medium
CD Glove	small	small	medium	large	large
GVO	11	10	13	13	11

TABLE B-8

COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
SIZES WORN BY MALE SUBJECTS

	x-sm ♂	small ♂	medium ♂	large ♂	x-large ♂
T-shirt	small	small	large	large	large
Long-Johns	small	small	medium	medium	large
Socks	medium	medium	medium	large	large
QBL Jacket	sm-short	sm-short	med-long	lg-short	xlg-regular
QBL Trouser	xsm-short	xsm-short	med-regular	med-regular	xlg-regular
Ballistic Vest	med-regular	med-regular	lg-regular	lg-regular	lg-long
Coveralls	med-short	med-short	med-regular	lg-regular	lg-regular
Gloves	9	10	10	10	10
Combat Boot	9 1/2 W	8 1/2 W	10 1/2 R	11 1/2 R	10 R
Helmet	large	large	large	large	large
Overalls	med-regular	med-regular	med-regular	lg-long	lg-long
Cold Weather Jacket	med-regular	med-regular	lg-regular	lg-regular	xlg-regular
Survival Vest	large	large	large	large	large
CD Coat	medium	medium	medium	large	large
CD Trouser	medium	small	medium	large	large
CD Glove Liner	small	medium	medium	medium	medium
CD Glove	small	small	medium	large	large
GVO	11	10	13	13	11

MEASURER'S FIT COMMENTS - PHASE II SUBJECTS

GROUND SOLDIER ENSEMBLE

EXTRA SMALL FEMALE

Layer 2	Sleeves baggy at biceps
	Many wrinkles in sleeves due to baggy arms
	Excess fabric between waist and shoulder on back causing many wrinkles
Layer 3	Baggy arms
	Coat too long - had to be raised to take VTC measurement
	Wrist too large at smallest adjustment
	Baggy knees
Layer 4	Overalls, too large

SMALL FEMALE

Layer 2	Legs and arms are baggy
Layer 3	Arms extremely long and baggy (at least 6" too long)
	Legs too long

MEDIUM FEMALE

Layer 2	Baggy sleeves

LARGE FEMALE

Layer 2	Coat baggy at waist
	6W boots too large, but best fit available (prefer 5 1/2W)
Layer 3	Legs too long (+ 3")
	Arms too long (+ 2")

EXTRA LARGE FEMALE

No comments

EXTRA SMALL MALE

No comments

SMALL MALE

No comments

MEDIUM MALE

Layer 2	Legs and sleeves baggy
Layer 3	Bunching at knee - lower leg baggy

LARGE MALE

No comments made

EXTRA LARGE MALE

Layer 3	Pant leg extremely baggy in lower leg
	Crotch height at midthigh

AVIATOR WARM WEATHER ENSEMBLE

EXTRA SMALL FEMALE

Layer 2	Legs too long - baggy below the knee
	Sleeves too long
	Rest of layer seems a fair fit
Layer 5	Sleeves too long
	Pants too long
	Jacket too long

SMALL FEMALE

Layer 2	Long sleeves and legs
	Legs baggy at ankle and lateral malleolus
	When sitting, legs baggy underneath
Layer 5	Legs too long - baggy

MEDIUM FEMALE

No comments

LARGE FEMALE

Layer 2	Legs a bit long - baggy below knees
Layer 5	Crotch height at midthigh

EXTRA LARGE FEMALE

Layer 2	Pant leg not to ankle - does not affect bimalleolar measurement
	Sleeve not to wrist - does not affect wrist measurement
	Legs too short
	Appears to fit tightly at hips but subject reports it is comfortable
Layer 5	Jacket seems too long
	Legs slightly long

EXTRA SMALL MALE

No comments

SMALL MALE

Layer 4	Vest is loose on the sides
	Wearing a large, but medium would be more appropriate

MEDIUM MALE

Layer 2	Snug fit through shoulders
	Good leg length
	Sleeves a little short - wrist not affected
	Baggy lower legs

LARGE MALE

No comments

EXTRA LARGE MALE:

No comments

AVIATOR COLD WEATHER ENSEMBLE

EXTRA SMALL FEMALE

Layer 2	Legs and sleeves too long
	Generally baggy
Layer 3	Sleeves slightly long - baggy arms
	Legs a few inches too long - baggy legs
Layer 4	Baggy all over
	Legs slightly long
Layer 6	Large SARVIP too big, but small would not close in front
Layer 7	Pants much too long causing bunching at knee and prevents ankle from being zipped completely down
	Crotch height at midthigh

SMALL FEMALE

Layer 2	Snug in waist
	Sleeves too long (+ 4")
	Legs too long (+ 1 - 2")

MEDIUM FEMALE

Layer 2	Sleeves too long (+ 2")
Layer 7	Crotch height at midthigh

LARGE FEMALE

Layer 2	Legs too long (+ 2")
	Crotch height at midthigh
Layer 3	Legs too long (+ 3")
	Crotch height at midthigh
Layer 7	Crotch height at midthigh

EXTRA LARGE FEMALE

Layer 2	Sleeves too long
	Jacket baggy in back
Layer 3	Sleeves slightly long
	Loose in back - good fit below waist
Layer 7	Crotch height at midthigh

EXTRA SMALL MALE

Layer 7	Legs too long (+ 5")
	Sleeves too long (+ 3")
	Crotch height at midthigh

SMALL MALE

Layer 4	Baggy in seat
	Legs too long (+ 3 1/2")
Layer 7	Legs too long (+ 5")
	Sleeves too long (+ 3")

MEDIUM MALE

Layer 1	Baggy at ankles
Layer 2	Sleeves slightly long
	Legs too long (+ 3")
	Crotch height at midthigh
Layer 3	Overalls, good fit
Layer 7	Crotch height at midthigh

LARGE MALE

Layer 2	Sleeves too long (+ 1-1 1/2")
	Overall fit is good
Layer 4	Legs too long (+ 3 1/2")

EXTRA LARGE MALE

Layer 2	Baggy in seat, otherwise good fit
Layer 4	Crotch height at midthigh
	Legs slightly long (+ 2 - 3")
Layer 5	Largest size was utilized - still too small
Layer 7	Sleeves too long
	Legs much too long

COMBAT VEHICLE CREMAN WARM WEATHER ENSEMBLE

EXTRA SMALL MALE

Layer 4	Baggy below the waist
	Sleeves too long (+ 2")
Layer 6	Legs too long (baggy at knees)
	Ballistic vest interferes with waist (pants tend to fall down)

SMALL MALE

Layer 4	Legs baggy at the knees
	Sleeves generally baggy

MEDIUM MALE

Layer 6	Crotch height at midthigh
	Legs too long
	Pockets on survival vest interfere with waist

LARGE MALE

Layer 6	Crotch height at midthigh

EXTRA LARGE MALE

No comments

COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE

EXTRA SMALL MALE

Layer 5	Legs too long (+ 3")
	Crotch height at midthigh
Layer 8	Legs much too long (+ 5")
	Crotch height at midthigh

SMALL MALE

Layer 5	Legs too long (+ 3")
Layer 8	Legs too long - unable to completely close zipper at ankle

MEDIUM MALE

Layer 5	Legs too long (+ 3")
Layer 8	Unable to close zipper completely at ankle
	Baggy at knees
	Crotch height at midthigh

LARGE MALE

No comments

EXTRA LARGE MALE

Layer 5	Legs too long (+ 5")
	Otherwise, good fit
	Crotch height at midthigh
Layer 6	Largest size was utilized - still too tight
	Closed with difficulty
Layer 7	With back fully loosened, vest still too small - vest could not be zipped so string was used to hold the vest closed, leaving a gap approximately 3-4" wide across the front of the vest
Layer 8	Crotch height at midthigh

APPENDIX C

NUDE LANDMARK AND MEASUREMENT DESCRIPTIONS

SOURCES:

ANSURE = Clauser et al., 1988; Gordon et al., 1989
USAF = Clauser et al., 1977
NATO = Hertzberg, et al., 1963

No reference given = Measurement was developed for current study.

LANDMARK DESCRIPTIONS

ACROMION, RIGHT AND LEFT (USAF)

The lateral margin of the acromial process of the scapula. Subject stands with arms relaxed at sides. The lateral margin of each acromial process is determined by palpation and marked with a short horizontal line.

ANKLE POINT (ANSUR)

A point on the lateral side of the ankle at the level of the minimum circumference of the ankle. The level of the minimum circumference is established with a tape, and marked with a short horizontal line.

AXILLA (ANSUR)

A point on the torso at the axillary fold where the arm joins the torso. Subject is in the anthropometric standing position. These landmarks are drawn with the subject standing erect and the arms relaxed at the sides, but after a plastic rule has been placed firmly into the armpit in a horizontal position. The rule is placed while the subject has the hand on the hip. A short horizontal line is drawn on the torso at the top of the rule on the anterior side. (Note: This is the same landmark as ANSUR's Anterior Scye on the torso Landmark)

BICEPS POINT (ANSUR)

The highest point of the right flexed biceps as viewed from the subject's right side. Subject stands with the right upper arm extended forward horizontally and the elbow flexed about 90 degrees. The fist is tightly clenched and held facing the head. The highest point on the flexed biceps is located by inspection and marked with a short line perpendicular to the long axis of the upper arm.

BUSTPOINT, RIGHT AND LEFT (ANSUR)

The anterior points of the bra cups. Subject is in the anthropometric standing position. The most protruding point of the bra over each breast is determined by viewing the bust from the right side. A dot is drawn on each landmark.

BUTTOCK POINT, RIGHT LATERAL AND LEFT LATERIAL (ANSUR)

Points at the level of the maximum protrusion of the right buttock. Subject is in the anthropometric standing position. The point of maximum protrusion of the right buttock is located by inspection, and used to set the level of the landmark transfer rod. The transfer rod is used to establish the level of the landmark which is drawn as a short horizontal lines on both the right and the left thighs.

CALF (ANSUR)

A point on the side of the calf at the level of the maximum circumference of the right calf. Subject is in the anthropometric standing position. The level of the maximum circumference is established with a tape, and the landmark is drawn as a short horizontal line on the lateral side of the calf.

CERVICALE (ANSUR)

The superior palpable point of the spine of the seventh cervical vertebra. Subject is in the anthropometric standing position with the head in the Frankfort plane. The spine of the seventh cervical vertebra is the most prominent vertebral spine of the back of the neck. A cross is drawn through the superior point of the spine of the seventh cervical vertebra.

DACTYLION III, RIGHT AND LEFT (ANSUR)

The tip of the middle finger. This is not a drawn landmark.

DELTOID POINT, RIGHT, LEFT, ANTERIOR, AND POSTERIOR (ANSUR)

The lateral point of the right deltoid muscle, the margin of the left deltoid muscle at the level of the right deltoid point, and the chest and back at the level of the right deltoid point. Subject is in the anthropometric standing position. The most protruding point of the right upper arm overlaying the deltoid muscle is located by inspection when the subject is viewed from the front. A short horizontal mark is drawn through the landmark. The landmark transfer rod is set at the height of the right deltoid landmark and used to establish the location of the left, anterior, and posterior deltoid landmarks.

ECTOORBITALE (ANSUR)

The posterior point on the marginal process of the zygomatic bone at the level of the outer corner of the eye (ectocanthus). It is located by palpation and marked with a dot.

ELBOW CREASE (ANSUR)

The skin crease on the inside of the elbow joint when the elbow is flexed 90 degrees. It is not a drawn landmark.

FIFTH METATARSOPHALANGEAL PROTRUSION (ANSUR)

The most lateral protrusion of the right foot in the region of the fifth metatarsophalangeal joint. Subject stands on a graph paper on a table with the weight distributed equally on both feet. The right foot is positioned in such a way that the inside of the foot is parallel to a line on the table. The maximum protrusion on the outside of the foot near the little toe is located by inspection when the foot is viewed from the front. A short vertical line is drawn through the landmark.

FIRST METATARSOPHALANGEAL PROTRUSION (ANSUR)

The most medial protrusion of the right foot in the region of the first metatarsophalangeal joint. Subject stands on a table with the weight distributed equally on both feet. The right foot is positioned in such a way that the inside of the foot is parallel to a line on the table. The maximum protrusion on the inside of the foot near the big toe is located by inspection when the foot is viewed from the front. A short vertical line is drawn through the landmark.

GLABELLA (ANSUR)

The most anterior point on the frontal bone midway between the bony browridges. It is located by inspection and palpation and marked with a dot.

INFRAORBITALE, RIGHT AND LEFT (ANSUR)

The lowest point on the anterior border of the bony eye socket. Subject stands, looking straight ahead. The bony eye socket under the eye is palpated to locate its lowest point. A dot is drawn on the landmark.

INFRATHYROID (ANSUR)

The inferior point in the midsagittal plane of the thyroid cartilage (Adam's apple). Subject stands with the head in the Frankfort plane. The landmark is located by palpation, and a short horizontal line is drawn through the landmark.

LATERAL FEMORAL EPICONDYLE, STANDING (ANSUR)

Lateral point of the right femoral epicondyle (knee pivot point). Subject stands erect with the weight distributed equally on both feet. The landmark is located by palpation and a cross is drawn through the landmark.

LATERAL MALLEOLUS (ANSUR)

The lateral point of the right lateral malleolus (an ankle bone). Subject stands with the weight distributed equally on both feet. The most protruding point on the lateral malleolus (the ankle bone on the outside of the foot) is located by inspection. A cross is drawn through the point.

MENTON (ANSUR)

The inferior point of the mandible in the midsagittal plane (bottom of the chin). Subject stands, looking straight ahead, with the teeth together. The landmark is located by palpation of the lower jawbone just under the chin. A dot is drawn on the landmark.

METACARPALE II (ANSUR)

The lateral point of the right metacarpophalangeal joint II (at the base of the index finger). Subject stands. The landmark is located on the side of the hand at the base of the index finger. The most laterally protruding point of the metacarpophalangeal joint II is located by grasping the subject's hand and palpating the area. A short line perpendicular to the long axis of the finger is drawn through the landmark.

METACARPALE V (ANSUR)

The medial point of the right metacarpophalangeal joint V (at the base of the little finger). Subject stands. The landmark is located on the side of the hand at the base of the little finger. The most medially protruding point of the metacarpophalangeal joint V is located by grasping the subject's hand and palpating the area. A short line perpendicular to the long axis of the finger is drawn through the landmark.

MIDPATELLA (ANSUR)

The anterior point halfway between the top and bottom of the right patella (the kneecap). Subject stands erect with the knee relaxed. The midpoint of the patella is established by sight and a short horizontal line is drawn through the landmark.

MIDSHOULDER (ANSUR)

The point on top of the right shoulder midway between the neck and the tip of the shoulder (acromion, right). Subject stands in the anthropometric standing position. A tape is laid along the top of the shoulder from the neck landmark to the acromion landmark at the tip of the shoulder. A line is drawn from front to back across the shoulder at one-half the measured distance between those two landmarks.

MIDTHIGH

The midpoint between the trochanterion and lateral femoral epicondyle landmarks on the lateral side of the right leg. The subject is in the anthropometric standing position. A tape is laid along the lateral surface of the thigh. A short line is drawn on the thigh at one-half the measured distance between the two landmarks.

NECK, LATERAL (ANSUR)

The lateral point at the base of the neck. The subject stands looking straight ahead. A tape is placed around the base of the neck, as if to measure Neck Circumference, Base (ANSUR). A short mark is drawn along the base of the tape at its most lateral point.

OLECRANON, CENTER (ANSUR)

A point on the center of the curvature of the right olecranon process (the elbow) with the elbow flexed about 115 degrees. Subject stands with the fists together in such a way that the metacarpophalangeal and proximal interphalangeal knuckles are touching. With the volar surfaces of the hands facing outward and the palm sides facing inward, the subject's arms are raised until they are in a horizontal position roughly parallel to the standing surface. The forearms and fists are in a straight line. The center of the curvature of the elbow is located by inspection and a short vertical line is drawn through the landmark.

PTERNION (ANSUR)

The posterior point of the right heel. The landmark is determined by inspection and is not marked.

RADIALE (ANSUR)

The highest point on the outside edge of the radius. Subject stands relaxed. The landmark is located by palpation and a cross is drawn through the point.

SELLION (ANSUR)

The point of the deepest depression of the nasal bones at the top of the nose. Subject stands, looking straight ahead. The point of deepest depression of the bridge of the nose in the midsagittal plane is located by palpation. On some subjects, there is no distinctly deepest point and judgment is used to establish its location. A dot is drawn on the bridge of the nose at the landmark.

STYLION (ANSUR)

The lowest point of the bottom of the radius. Subject stands relaxed. The landmark is located by palpation and a cross is drawn over the landmark.

SUBMANDIBULAR (ANSUR)

The juncture, in the midsagittal plane, of the lower jaw and the neck. Subject stands with the head in the Frankfort plane. The landmark is located by placing a marking pencil on the underside of the jaw and lightly rolling it back towards the neck until it is stopped by the neck. A short horizontal line is drawn at this point.

SUPRAPATELLA (ANSUR)

The superior point of the patella (kneecap). Subject stands erect with the patella relaxed. The index finger is used to locate the top of the patella. When the top of the kneecap has been located a short horizontal line is drawn through the point.

SUPRASTERNALE (ANSUR)

The inferior point of the jugular notch of the sternum (top of the breastbone). Subject is in the anthropometric standing position. The bottom of the notch of the sternum is located by palpation. A short horizontal line is drawn through the landmark.

THELION, RIGHT AND LEFT (ANSUR)

The center of the nipple (on males). It is located by inspection, but is not drawn.

THIGH POINT, TOP (ANSUR)

The highest point of the top of the right thigh of a seated subject. Subject sits in the anthropometric sitting position. The landmark is located by brushing with the blade of the anthropometer. It is not drawn.

TOP OF HEAD (ANSUR)

The highest point on the head when the head is in the Frankfort plane. Subject is in the anthropometric standing position. The landmark is located by brushing with the blade of the anthropometer. It is not drawn.

TRAGION, RIGHT AND LEFT (ANSUR)

The superior point on the juncture of the cartilaginous flap (tragus) of the ear with the head. The landmarks are located by palpating the tragus. A dot is placed on each landmark.

TROCHANTERION (ANSUR)

The superior point of the greater trochanter of the right femur of a standing subject. Subject stands erect with weight distributed equally on both feet. A short horizontal line is drawn at the level of the landmark.

WAIST (OMPHALION): RIGHT AND LEFT; ANTERIOR AND POSTERIOR (ANSUR)

The level of the center of the navel. Subject is in the anthropometric standing position. The landmark is located by inspection. A 4-cm horizontal line is drawn across omphalion, and with a landmark transfer rod set at the height of omphalion, 4-cm horizontal lines are drawn on the right and left sides and over the spine of the subject. The landmarks are drawn at the maximum point of quiet respiration.

MEASUREMENT DESCRIPTIONS

ACROMIAL HEIGHT (ANSUR)

The vertical distance between a standing surface and the acromion landmark on the tip of the right shoulder is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is made at the maximum point of quiet respiration. Note: USAF definition of acromion used.

ACROMIAL HEIGHT, SITTING (ANSUR)

The vertical distance between a sitting surface and the acromion landmark on the tip of the right shoulder is measured with an anthropometer. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quiet respiration. Note: USAF definition of acromion used.

ACROMION-RADIALE LENGTH (ANSUR)

The distance between the acromion landmark on the tip of the right shoulder and the radiale landmark on the right elbow is measured with a beam caliper held parallel to the long axis of the arm. The subject stands erect. The shoulders and upper extremities are relaxed with the palms facing the thighs. Note: USAF definition of acromion used.

ANKLE BREADTH

The horizontal breadth of the ankle is measured at the level of the minimum circumference with a sliding caliper. The measurement is taken perpendicular to the long axis of the leg. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

ANKLE CIRCUMFERENCE (ANSUR)

The minimum horizontal circumference of the right ankle is measured with a tape. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

ANKLE DEPTH

The horizontal depth of the ankle is measured at the level of the minimum circumference with a sliding caliper. The measurement is taken perpendicular to the long axis of the leg. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

ANKLE HEIGHT

The vertical distance between a standing surface and the right ankle landmark at the level of the minimum ankle circumference is measured with a headboard gauge (a modified sliding caliper). The subject stands with heels together and the weight distributed equally on both feet.

AXILLA HEIGHT (ANSUR)

The vertical distance between a standing surface and the right axillary fold, as designated by the axilla landmark, is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed with the palms facing the thighs. The measurement is taken at the maximum point of quiet respiration.

BALL OF FOOT CIRCUMFERENCE (ANSUR)

The circumference of the foot at the first and fifth metatarsophalangeal landmarks on the ball of the right foot is measured with a tape. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

BALL OF FOOT LENGTH (ANSUR)

The distance from the back of the heel (pternion) to the landmark at the first metatarsophalangeal protrusion on the ball of the right foot is measured in a footbox. The subject stands erect with each foot in a footbox. The weight is distributed equally on both feet. The medial side of the right foot is parallel with the long axis of the box.

BIACROMIAL BREADTH (ANSUR)

The distance between the right and left acromion landmarks at the tips of the shoulders is measured with a beam caliper. The subject stands erect. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is taken at the maximum point of quiet respiration. Note: USAF definition of Acromion used.

BICEPS BREADTH, FLEXED

The breadth of the right biceps is measured at the level of the biceps point landmark with a sliding caliper. The measurement is perpendicular to the long axis of the upper arm. The subject stands with the upper arm extended forward horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head, and the subject exerts maximum effort in "making a muscle."

BICEPS CIRCUMFERENCE, FLEXED (ANSUR)

The circumference of the right upper arm around the flexed biceps muscle is measured with a tape held perpendicular to the long axis of the upper arm. The subject stands with the upper arm extended forward horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head, and the subject exerts maximum effort in "making a muscle."

BICEPS DEPTH, FLEXED

The depth of the right biceps is measured at the level of the biceps point landmark with a sliding caliper. The measurement is taken perpendicular to the long axis of the upper arm. The subject stands with the upper arm extended forward horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head, and the subject exerts maximum effort in "making a muscle."

BIDELTOID BREADTH, UNCOMPRESSED (ANSUR)

The horizontal distance between the lateral margins of the upper arms at the deltoid landmarks is measured with a beam caliper. The subject stands erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quiet respiration.

BIMALLEOLAR BREADTH (ANSUR)

The horizontal distance between the maximum protrusions of the ankle bones (lateral and medial malleoli) of the right foot is measured with a Holtain caliper. The subject stands with the weight equally distributed on both feet.

BITRAGION BREADTH (USAF)

The straight-line distance between the right and left tragion landmarks on the cartilaginous flaps in front of each ear hole is measured with a spreading caliper.

BUTTOCK CIRCUMFERENCE, UNCOMPRESSED (ANSUR)

The horizontal circumference of the trunk at the level of the maximum protrusion of the right buttock is measured with a tape. The subject stands erect with the heels together and the weight equally distributed on both feet.

BUTTOCK DEPTH, UNCOMPRESSED (ANSUR)

The horizontal depth of the torso at the level of the maximum protrusion of the right buttock is measured using a beam caliper. The subject stands erect with the heels together and the weight distributed equally on both feet.

BUTTOCK HEIGHT (ANSUR)

The vertical distance between a standing surface and the level of the maximum protrusion of the right buttock is measured with an anthropometer at the right side of the thigh. The subject stands erect with the heels together and the weight distributed equally on both feet.

BUTTOCK-KNEE LENGTH (ANSUR)

The horizontal distance between a buttock plate placed at the most posterior point on either buttock and the anterior point of the right knee is measured with an anthropometer. The subject sits erect. The thighs are horizontal and parallel to each other and the knees are flexed 90 degrees with the feet in line with the thighs.

BUTTOCK-POPLITEAL LENGTH (ANSUR)

The horizontal distance between a buttock plate placed at the most posterior point on either buttock and the back of the right knee (at the dorsal juncture of the calf and thigh), is measured with an anthropometer. The subject sits erect. The thighs are horizontal and parallel to each other and the knees are flexed 90 degrees with the feet in line with the thighs.

CALF BREADTH

The horizontal breadth of the right leg at the level of the maximum calf circumference is measured with a beam caliper. The measurement is made perpendicular to the long axis of the calf. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF CIRCUMFERENCE (ANSUR)

The maximum horizontal circumference of the right calf is measured with a tape. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF DEPTH

The horizontal depth of the right leg at the level of the maximum calf circumference is measured with a beam caliper. The measurement is made perpendicular to the long axis of the calf. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF HEIGHT (ANSUR)

The vertical distance between a standing surface and the calf point landmark at the level of the maximum circumference of the right calf is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

CHEST BREADTH (ANSUR)

The maximum horizontal breadth of the chest at the level of the right bustpoint on women or the nipple on men is measured with a beam caliper. The subject stands erect looking straight ahead with the heels together, and the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration. **Note:** Breast tissue and latissimus dorsi muscle tissue are NOT included in this measurement if they extend beyond the rib cage.

CHEST CIRCUMFERENCE (ANSUR)

The maximum horizontal circumference of the chest at the fullest part of the breast is measured with a tape. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST DEPTH (ANSUR)

The horizontal distance between the chest at the level of the right bustpoint on women or the nipple on men, and the back at the same level is measured with a beam caliper. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST DEPTH-DELTOID POINT, UNCOMPRESSED

The horizontal distance between the chest at the level of the deltoid point, and the back at the same level is measured with a beam caliper. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST HEIGHT (ANSUR)

The vertical distance between a standing surface and the right bustpoint on women or the nipple on men is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CROTCH HEIGHT (ANSUR)

The vertical distance between the standing surface and the crotch is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together and the weight is distributed equally on both feet.

DELTOID POINT HEIGHT

The vertical distance between the standing surface and the deltoid point landmark on the lateral point of the right deltoid muscle is measured with an anthropometer. The subject stands erect. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

ECTOORBITALE-TOP OF HEAD (NATO)

The vertical distance between the ectoorbitale landmark just behind the bony eye socket at the level of the outer corner of the eye and the horizontal plane tangent to the top of the head is measured using a headboard and headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard and the top of the head the horizontal overhead plate.

ELBOW BREADTH

The breadth of the elbow is measured at the level of the lateral and medial epicondyles of the humerus with a beam caliper. The measurement is taken perpendicular to the long axis of the arm. The subject stands with the elbow straight, the arm held away from the body at 45 degrees and the palm facing forward

ELBOW CIRCUMFERENCE (ANSUR)

The circumference of the right elbow in a plane perpendicular to the long axis of the arm is measured with a tape passing around the elbow at the level of the olecranon landmark. The subject stands with the elbow straight, the arm held away from the body at 45 degrees and the palm facing forward

ELBOW DEPTH

The depth of the elbow is measured at the level of the olecranon landmark with a beam caliper. The measurement is taken perpendicular to the long axis of the arm. The subject stands with the elbow straight, the arm held away from the body at 45 degrees and the palm facing forward

EYE HEIGHT, SITTING (ANSUR)

The vertical distance between a sitting surface and the ectocanthus landmark on the outer corner of the right eye is measured with an anthropometer. The subject sits erect with the head in the Frankfort plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are horizontal and parallel to each other and the knees are flexed 90 degrees with the feet in line with the thighs. The measurement is taken at the maximum point of quiet respiration.

FOOT BREADTH, HORIZONTAL (ANSUR)

The maximum breadth of the right foot is measured on a footbox scale. The subject stands with each foot in a footbox and the weight distributed equally on both feet. The heel of the right foot lightly touches the back of the box, and the side of the foot at the fifth-metatarsophalangeal-protrusion landmark lightly touches the side of the box. The medial side of the foot is parallel to the long axis of the box. A block is placed against the landmark at the first metatarsophalangeal protrusion to establish the measurement on the scale.

FOOT LENGTH (ANSUR)

The maximum length of the right foot is measured on a footbox scale. The subject stands with each foot in a footbox and the weight distributed equally on both feet. The heel of the right foot lightly touches the back of the box, and the side of the foot at the fifth-metatarsophalangeal-protrusion landmark lightly touches the side of the box. The medial side of the foot is parallel to the long axis of the box. A block is placed against the tip of the longest toe to establish the measurement on the scale.

FOREARM BREADTH, FLEXED

The breadth of the right forearm is measured with a sliding caliper at the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

FOREARM CIRCUMFERENCE, FLEXED (ANSUR)

The circumference of the flexed right forearm is measured with a tape passing across the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

FOREARM DEPTH

The depth of the right forearm is measured with a sliding caliper at the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

HAND BREADTH (ANSUR)

The breadth of the right hand between the landmarks at metacarpale II and metacarpale V is measured with a sliding caliper. The subject places the palm on a table, the fingers together and the thumb abducted. The middle finger is parallel to the long axis of the forearm. The two distal phalanges of the fingers lie on a flat surface 8 mm higher than the table.

HAND CIRCUMFERENCE (ANSUR)

The circumference of the right hand is measured with a tape passing over the landmarks at metacarpale II and metacarpale V. The subject places the palm on a table, the fingers together, and the thumb abducted. The middle finger is parallel to the long axis of the forearm. The two distal phalanges of the fingers lie on a flat surface 8 mm higher than the table.

HAND LENGTH (ANSUR)

The length of the right hand between the stylion landmark on the wrist and the tip of the middle finger is measured with a beam caliper. The subject places the palm on a table, the fingers together, and the thumb abducted. The middle finger is parallel to the long axis of the forearm. The two distal phalanges of the fingers lie on a flat surface 8 mm higher than the table.

HAND THICKNESS

The thickness of the right hand at the third metacarpophalangeal joint is measured with a sliding caliper. The subject holds the hand, palm down, with the fingers straight and together.

HEAD BREADTH (ANSUR)

The maximum horizontal breadth of the head above the plane of the attachment of the ears is measured with a spreading caliper.

HEAD CIRCUMFERENCE (ANSUR)

The maximum circumference of the head above the attachment of the ears to the head is measured with a tape passing just above the ridges of the eyebrows and around the back of the head.

HEAD LENGTH (ANSUR)

The distance from the glabella landmark between the brow ridges to the posterior point on the back of the head is measured with a spreading caliper.

HEEL BREADTH (ANSUR)

The maximum horizontal distance between the medial and lateral points on the inside and outside of the right heel, at or posterior to the lateral malleolus landmark, is measured with a Holtain caliper. The measurement is taken just above the level of the standing surface at the most protruding points of the curvature of the heel. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

HIP BREADTH, UNCOMPRESSED (ANSUR)

The horizontal distance between the lateral buttock landmarks on the sides of the hips is measured with a beam caliper. The subject stands erect with the heels together and the weight distributed equally on both feet.

KNEE BREADTH

The breadth of the right knee at the level of the midpatella landmark is measured with a beam caliper. The measurement is made perpendicular to the long axis of the leg. The subject stands erect with the feet about 10 cm apart and the weight distributed equally on both feet.

KNEE CIRCUMFERENCE (ANSUR)

The horizontal circumference of the right knee at the level of the midpatella landmark at the center of the knee is measured with a tape. The subject stands erect with the feet about 10 cm apart and the weight distributed equally on both feet.

KNEE DEPTH

The depth of the right knee at the level of the midpatella landmark is measured with a beam caliper. The measurement is made perpendicular to the long axis of the leg. The subject stands erect with the feet about 10 cm apart and the weight distributed equally on both feet.

KNEE HEIGHT, MIDPATELLA (ANSUR)

The vertical distance between a standing surface and the midpatella landmark at the center of the right knee is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

KNEE HEIGHT, SITTING (ANSUR)

The vertical distance between a footrest surface and the suprapatella landmark at the top of the right knee (located and drawn while the subject stands) is measured with an anthropometer. The subject sits with the thighs horizontal and parallel to each other, the knees flexed 90 degrees, and the feet in line with the thighs.

LATERAL FEMORAL EPICONDYLE HEIGHT (ANSUR)

The vertical distance between a standing surface and the lateral femoral epicondyle landmark on the outside of the right knee is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

LATERAL MALLEOLUS HEIGHT (ANSUR)

The vertical distance between a standing surface and the lateral malleolus landmark on the outside of the right ankle is measured with a headboard gauge (a modified sliding caliper). The subject stands erect with the heels together and the weight distributed equally on both feet.

MENTON-SELLION LENGTH (ANSUR)

The distance between the menton landmark at the bottom of the chin and the sellion landmark at the deepest point of the nasal root depression is measured with a sliding caliper. The teeth are lightly occluded.

MENTON-TOP OF HEAD (NATO)

The vertical distance between the menton landmark at the bottom of the chin and the horizontal plane tangent to the top of the head is measured using a headboard and a headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard and the top of the head the horizontal overhead plate.

MIDSHOULDER HEIGHT

The vertical distance between a standing surface and the midshoulder landmark at the top of the right shoulder is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

MIDSHOULDER HEIGHT, SITTING (ANSUR)

The vertical distance between a sitting surface and the midshoulder landmark at the top of the right shoulder is measured with an anthropometer. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is taken at the maximum point of quiet respiration.

MIDTHIGH BREADTH

The breadth of the right thigh at the midthigh landmark (the midpoint between trochanterion and lateral femoral epicondyle) is measured with a beam caliper. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch.

MIDTHIGH CIRCUMFERENCE

The circumference of the right thigh at the midthigh landmark (the midpoint between trochanterion and lateral femoral epicondyle) is measured with a tape. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch.

MIDTHIGH DEPTH

The depth of the right thigh at the midthigh landmark (the midpoint between trochanterion and lateral femoral epicondyle) is measured with a beam caliper. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch.

MIDTHIGH HEIGHT

The vertical distance between a standing surface and the midthigh landmark (the midpoint between trochanterion and lateral femoral epicondyle) on the right thigh is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet.

NECK BREADTH

The breadth of the neck is measured at the level of the infrathyroid landmark (Adam's apple) with a beam caliper. The measurement is taken perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane.

NECK CIRCUMFERENCE (ANSUR)

The circumference of the neck at the level of the infrathyroid landmark (Adam's apple) is measured with a tape. The plane of the measurement is perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane. The shoulders and upper extremities are relaxed.

NECK DEPTH

The depth of the neck is measured at the level of the infrathyroid landmark (Adam's apple) with a beam caliper. The measurement is taken perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane.

NECK HEIGHT, LATERAL (ANSUR)

The vertical distance between a standing surface and the lateral neck landmark on the right side of the neck is measured with an anthropometer. The subject stands erect with the head in the Frankfort plane. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

POPLITEAL HEIGHT (ANSUR)

The vertical distance from a footrest surface to the back of the right knee (at the dorsal juncture of the right calf and thigh) is measured with an anthropometer. The subject sits with the thighs horizontal and parallel to each other, the feet in line with the thighs, and the knees flexed 90 degrees.

RADIALE-STYLION LENGTH (ANSUR)

The distance between the radiale landmark on the right elbow and the stylion landmark on the right wrist is measured with a beam caliper held parallel to the long axis of the forearm. The subject stands with the arms relaxed at the sides. The hand and fingers are held straight in line with the long axis of the forearm.

SELLION-BACK OF HEAD (NATO)

The horizontal distance between the sellion landmark at the deepest point of the root of the nose and the vertical plane tangent to the back of the head is measured using a headboard and a headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard, and the top of the head touches the horizontal overhead plate.

SELLION-TOP OF HEAD (NATO)

The vertical distance between the sellion landmark at the deepest point of the root of the nose and the horizontal plane tangent to the top of the head is measured using a headboard and a headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard, and the top of the head touches the horizontal overhead plate.

SHOULDER CIRCUMFERENCE, UNCOMPRESSED (ANSUR)

The horizontal circumference of the shoulders at the level of the maximum protrusion of the right deltoid muscle is measured with a tape. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed with the palms facing the thighs. The measurement is taken at the maximum point of quiet respiration.

SITTING HEIGHT (ANSUR)

The vertical distance between a sitting surface and the top of the head is measured with an anthropometer. The subject sits erect with the head in the Frankfort plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are horizontal and parallel to each other and the knees are flexed 90 degrees with the feet in line with the thighs. The measurement is made at the maximum point of quiet respiration.

STATURE (ANSUR)

The vertical distance from a standing surface to the top of the head is measured with an anthropometer. The subject stands erect with the head in the Frankfort plane. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

THIGH BREADTH

The breadth of the right thigh at its juncture with the buttock is measured with a beam caliper. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch.

THIGH CIRCUMFERENCE (ANSUR)

The circumference of the right thigh at its juncture with the buttock is measured with a tape. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch.

THIGH CLEARANCE (ANSUR)

The vertical distance between a sitting surface and the highest point on the top of the right thigh is measured with an anthropometer. The subject sits with the thighs horizontal and parallel to each other, knees flexed 90 degrees, and the feet in line with the thighs.

THIGH DEPTH

The depth of the right thigh at its juncture with the buttock is measured with a beam caliper. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch. THIGH DEPTH, CROTCH is the clothed analog to the nude thigh depth.

TROCHANTERION HEIGHT (ANSUR)

The vertical distance between a standing surface and the trochanterion landmark on the upper side of the right thigh is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet.

VERTICAL TRUNK CIRCUMFERENCE (ANSUR)

The vertical circumference of the torso is measured with a tape passing between the buttocks, to the right of the genitalia, over the right bustpoint landmark on women or the nipple (thelion) on men, and across the midshoulder landmark. The subject stands erect looking straight ahead with the right arm hanging relaxed at the side. The heels are together with the weight distributed equally on both feet. The measurement is taken at the midpoint of quiet respiration. Note: This dimension is identical to ANSUR's Vertical Trunk Circumference (ASCC).

WAIST BREADTH (ANSUR)

The horizontal breadth of the waist at the level of the center of the navel (omphalion) is measured with a beam caliper. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

WAIST CIRCUMFERENCE (OMPHALION)(ANSUR)

The horizontal circumference of the waist at the level of the center of the navel (omphalion) is measured with a tape. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The measurement is made at the maximum point of quiet respiration.

WAIST DEPTH (OMPHALION)(ANSUR)

The horizontal distance between the front and back of the torso at the level of the center of the navel (omphalion) is measured with a beam caliper. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

WAIST HEIGHT (OMPHALION)(ANSUR)

The vertical distance between a standing surface and the center of the navel (omphalion) is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is made at the maximum point of quiet respiration.

WEIGHT (ANSUR)

The weight of the subject is taken to the nearest tenth of a kilogram. The subject stands on the platform of a beam scale with the weight distributed equally on both feet.

WRIST BREADTH

The breadth of the wrist is measured between the radial and ulnar styloid processes with a sliding caliper. The measurement is taken perpendicular to the long axis of the forearm. The subject stands with the upper arms relaxed, the elbow flexed at 90 degrees and the palm facing upward.

WRIST CIRCUMFERENCE (ANSUR)

The circumference of the wrist perpendicular to the long axis of the forearm is measured with a tape passing over the stylion landmark on the wrist. The subject stands with the upper arms relaxed, the elbow flexed at 90 degrees and the palm facing upward.

WRIST DEPTH

The depth of the wrist is measured at the level of the stylion landmark with a sliding caliper. The measurement is taken perpendicular to the long axis of the forearm. The subject stands with the upper arms relaxed, the elbow flexed at 90 degrees and the palm facing upward.

APPENDIX D

CLOTHED LANDMARK AND MEASUREMENT DESCRIPTIONS

CLOTHED LANDMARK DESCRIPTIONS

ACROMION, RIGHT AND LEFT

The level of the nude acromion point transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the nude acromion landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line on the right and left shoulders of the clothing at the level of the nude landmark. The subject stands erect looking straight ahead with the heels together and the arms relaxed at the sides.

ANKLE POINT

The level of the nude ankle point transferred to the clothed subject. Before clothing or boots are donned, the distance from the nude calf landmark to the nude ankle landmark is measured with a tape. After the subject is clothed, the tape is used to locate the clothed ankle landmark as a measured distance from the clothed calf landmark. At this level, a short horizontal line is drawn on the clothing. The subject stands with the weight equally distributed on both feet.

BICEPS POINT

The level of the nude biceps point transferred to the clothed subject. Before clothing is donned, the subject extends the right arm forward horizontally and the distance from dactylion III to the biceps landmark is measured with a tape. After the subject is clothed, but without gloves, the tape is used to determine the position of a short horizontal line drawn on the right arm of the clothing.

BUTTOCK POINT, POSTERIOR, ANTERIOR, RIGHT, AND LEFT

The level of the nude buttock point transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the nude buttock point landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish short horizontal lines on the posterior, anterior, right, and left sides of the clothing. The subject stands erect looking straight ahead with the heels together and the weight equally distributed on both feet.

CALF

The level of the nude calf landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the nude landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line on the right leg of the clothing. The subject stands erect looking straight ahead with the heels together and the weight equally distributed on both feet.

CERVICALE

The level of the nude cervicale landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the nude landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line on the posterior neck of the clothing. The subject stands erect looking straight ahead with the heels together and the arms relaxed at the sides.

CHEST, POSTERIOR, ANTERIOR, RIGHT, AND LEFT

The level of the nude chest landmarks transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the nude anterior chest landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line drawn on the posterior, anterior, right, and left sides of the clothing. The subject stands erect looking straight ahead with the heels together and the arms relaxed at the sides. The measurement is made at the maximum point of quiet respiration.

DACTYLION III, RIGHT AND LEFT

The tip of the middle finger of a gloved hand. It is not a drawn landmark.

DELTOID POINT, RIGHT, LEFT, ANTERIOR, AND POSTERIOR

The level of the nude deltoid landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line on the anterior, posterior, right, and left sides of the clothing. The subject stands erect looking straight ahead with the heels together and the shoulders relaxed with the arms at the sides.

INFRATHYROID

The level of the nude infrathyroid landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish a short horizontal line on the clothing. The subject stands erect looking straight ahead with the heels together and the weight equally distributed on both feet.

LATERAL FEMORAL EPICONDYLE

The level of the nude lateral femoral epicondyle landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish the level of a short horizontal line on the outer right leg of the clothing. The subject stands erect with the weight distributed equally on both feet.

LATERAL MALLEOLUS

The level of the nude lateral malleolus landmark transferred to the clothed subject. The distance between calf landmark and the lateral malleolus landmark is measured on the nude subject with a tape. After the subject is clothed, the tape is used to determine the position of a short horizontal line on the right ankle of the clothing. The subject stands erect with the weight equally distributed on both feet.

METACARPALE II

The lateral point of the right metacarpophalangeal joint II at the base of the index finger of the gloved hand. Its location is determined by palpation of the gloved hand. A mark is placed on the landmark.

METACARPALE V

The medial point of the right metacarpophalangeal joint V at the base of the little finger of the gloved hand. Its location is determined by palpation of the gloved hand. A mark is placed on the landmark.

MIDPATELLA

The level of the nude midpatella landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish the level of a short horizontal line on the right knee of the clothing. The subject stands erect with the weight equally distributed on both feet, with the knee relaxed.

MIDSHOULDER

One-half the distance between the clothed lateral neck landmark and the clothed acromion landmark. A tape is used to measure the distance between the two clothed landmarks. At one-half the measured distance a short line is drawn, front to back, on the right shoulder of the clothing. The subject stands erect looking straight ahead with the heels together and the shoulders relaxed with the arms at the sides.

MIDTHIGH

The level of the nude midthigh landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish the level of a short horizontal line on the right leg of the clothing. The subject stands erect looking straight ahead with the weight equally distributed on both feet.

NECK, RIGHT LATERAL

The nude lateral neck landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to locate a short horizontal line on the clothing. The subject stands erect looking straight ahead with the heels together and the shoulders relaxed with the arms at the sides.

OLECRANON, CENTER

The middle of the curvature of the olecranon process of the elbow of the clothed subject. The clothed subject makes fists and brings them together in such a way that the metacarpophalangeal and proximal interphalangeal knuckles are touching. With the volar surfaces of the hands facing outward and the palm sides facing inward, the subject raises the arms until they are in a horizontal position roughly parallel to the standing surface. The forearms and fists are in a straight line. The elbow is flexed approximately 115 degrees. The olecranon, center landmark is located by palpation through the clothing and a dot is drawn on the clothing over the landmark.

STYLION

The lowest point of the bottom of the radius of a clothed subject. The stylion landmark is located by palpation through the clothing, and a dot is drawn on the clothing over the landmark.

SUPRAPATELLA

The level of the nude suprapatella landmark transferred to the clothed subject. A ball bearing is taped to the nude knee on the suprapatella landmark. After the subject is clothed, the landmark is located by palpation. This landmark is not drawn.

THIGH AT CROTCH

The level of the crotch of the pants of a clothed subject transferred to the lateral side of the clothed leg. An anthropometer is placed into the crotch as if to measure Crotch Height. The blade is placed as high as possible without elevating the clothing in the crotch. The anthropometer is used to establish the level of the mark on the lateral side of the clothed thigh, where a short horizontal mark is drawn.

THIGH POINT, TOP

The highest point on the top of the right thigh of a seated clothed subject. The landmark is located by brushing the anthropometer blade and by visual inspection. It is not drawn.

TRAGION (EAR CUP)

1) For the aviator or CVC helmet, the center of the right and left ear cups. The centers of the ear cups are located by inspection and a small dot is placed on the landmark.

2) For the M40 mask and hood, the location of the nude tragion transferred to the clothed subject. The ear is palpated through the clothing to locate the right and left tragion. A small dot is placed on the mask or hood over the landmark.

TROCHANTERION

The nude trochanterion landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to locate a short horizontal line on the right leg of the clothing. The subject stands erect with the heels together and the weight equally distributed on both feet.

WAIST (OMPHALION): RIGHT AND LEFT; ANTERIOR AND SUPERIOR

The nude omphalion landmark transferred to the clothed subject. Appropriate footwear for the clothed condition is donned first. The vertical distance from the standing surface to the landmark is then determined with an anthropometer. After the subject is clothed, the anthropometer is used to establish the level of a short horizontal line on the anterior, superior, right, and left sides of the clothing. The subject stands erect looking straight ahead with the heels together and the weight equally distributed on both feet. This measurement is made at the maximum point of quiet respiration.

CLOTHED MEASUREMENT DESCRIPTIONS

ACROMIAL HEIGHT

The vertical distance between a standing surface and the clothed acromion landmark on the garment shoulder is measured with an anthropometer. The clothing is not compressed. The subject stands erect looking straight ahead with heels together and the arms relaxed at the sides. The measurement is made at the maximum point of quiet respiration.

ACROMIAL HEIGHT, SITTING

The vertical distance between a sitting surface and the clothed acromion landmark on the garment shoulder is measured with an anthropometer. The clothing is not compressed. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quiet respiration.

ACROMION-RADIALE LENGTH

This measurement is unchanged by the addition of clothing, and is not measured in the clothed condition.

ANKLE BREADTH

The breadth of the clothed ankle is measured over the clothing or boot on the right leg at the level of the clothed ankle landmark with a sliding caliper. The measurement is taken perpendicular to the long axis of the leg. The clothing is not compressed. The subject stands with the feet about 10 cm apart, and the weight distributed equally on both feet. When clothing covers the ankle, it is allowed to hang naturally and is not compressed before or during measurement.

ANKLE CIRCUMFERENCE

The circumference of the clothed right ankle is measured with a tape at the level of the clothed ankle landmark. Eighty grams of tension, as determined by an affixed spring tension scale, is applied to the tape. The tape is perpendicular to the long axis of the leg. The subject stands with the feet about 10 cm apart with the weight distributed equally on both feet.

ANKLE DEPTH

The depth of the clothed ankle is measured over the clothing or boot with a sliding caliper on the right leg at the level of the clothed ankle landmark. The measurement is taken perpendicular to the long axis of the leg. The clothing is not compressed. The subject stands with the feet about 10 cm apart, and the weight distributed equally on both feet. When clothing covers the ankle, it is allowed to hang naturally, and is not compressed before or during measurement.

ANKLE HEIGHT

The vertical distance between a standing surface and the level of the clothed ankle landmark of the right leg is measured with a headboard gauge (a modified sliding caliper). The subject stands erect with the heels together and the weight distributed equally on both feet.

AXILLA (SCYE) HEIGHT

The vertical distance between a standing surface and right scye is measured with an anthropometer. The right arm is raised slightly so the blade of the anthropometer can be positioned in the armpit without compressing the clothing. The arm is slowly lowered to the side. The shoulders and upper extremities are relaxed with the palms facing the thighs. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

BALL OF FOOT (BOOT) CIRCUMFERENCE

The circumference of the boot at the widest point below the base of the laces on the right foot is measured with a tape. The subject stands with the feet about 10 cm apart and the weight distributed equally on both feet.

BALL OF FOOT (BOOT) LENGTH

The length of the boot from the back of the heel to a point at the most medial projection at the ball of the foot (corresponding to the first metatarsophalangeal protrusion) on the right foot is measured in a footbox. The weight is distributed equally on both feet. The medial side of the right foot is parallel with the long axis of the box.

BIACROMIAL BREADTH

The distance between the right and left clothed acromion landmarks on the shoulders of the clothing is measured with a beam caliper. The clothing is not compressed. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is taken at the maximum point of quiet respiration.

BICEPS BREADTH, FLEXED

The breadth of the clothed flexed right biceps is measured with a beam caliper at the level of its flexed maximum circumference. The measurement is taken perpendicular to the long axis of the upper arm. The subject stands with the upper arm extended horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head. The clothing is allowed to bunch naturally and is not compressed during measurement.

BICEPS CIRCUMFERENCE, FLEXED

The circumference of the upper right arm around the flexed biceps is measured with a tape held perpendicular to the long axis of the upper arm. The subject stands with the upper arm extended horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head, and the subject exerts maximum effort in "making a muscle." The clothing is allowed to bunch naturally. Eighty grams of tension, as determined with a spring tension gauge, is applied to the tape.

BICEPS DEPTH, FLEXED

The depth of the right arm is measured with a beam caliper at the level of the clothed biceps point landmark. The measurement is taken perpendicular to the long axis of the upper arm. The clothing is allowed to bunch naturally and is not compressed during measurement. The subject stands with the upper arm extended forward horizontally and the elbow flexed 90 degrees. The fist is clenched and held facing the head.

BIDELTOID BREADTH, COMPRESSED

The horizontal distance between the clothed deltoid landmarks on the upper arms is measured on compressed clothing with a beam caliper. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quiet respiration. The clothing is compressed with a tape to which a spring tension scale is affixed, and which is positioned as if to measure shoulder circumference. Two hundred grams of tension are applied to the undergarment layer of clothing, and 600 grams to other clothing layers. A beam caliper is used to take the measurement over the top of the tape.

BIDELTOID BREADTH, UNCOMPRESSED

The horizontal distance between the clothed deltoid landmarks is measured with a beam caliper. The clothing is not compressed. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quiet respiration. To avoid compressing the clothing, the recorder helps place and stabilize the fixed blade of the caliper.

BIMALLEOLAR BREADTH

The horizontal breadth of the clothed ankle at the level of the clothed lateral malleolus landmark is measured over the boots or clothing with a beam caliper. The subject stands with the feet about 10 cm apart and the weight equally distributed on both feet.

BITRAGION (EAR CUP) BREADTH

The straight line distance between the right and left clothed tragion landmarks is measured with a spreading caliper. A beam caliper may be used if the measurement exceeds the measuring range of the spreading caliper.

BUTTOCK CIRCUMFERENCE, COMPRESSED

The horizontal circumference of the trunk at the level of the clothed buttock point landmarks is measured on compressed clothing with a tape that has an affixed spring tension scale. The subject stands erect with the heels together and the weight equally distributed on both feet. The clothing is compressed by applying 200 grams of tension to the undergarment layer and 600 grams to other clothing layers.

BUTTOCK CIRCUMFERENCE, UNCOMPRESSED

The horizontal circumference of the trunk at the level of the clothed buttock point landmarks is measured with a tape. Eighty grams of tension, as determined by an affixed spring tension scale, are applied to the tape. The subject stands erect with the heels together and the weight equally distributed on both feet.

BUTTOCK DEPTH, COMPRESSED

The horizontal depth of the torso at the level of the clothed buttock point landmarks is measured on compressed clothing with a beam caliper. Compression of the clothing is done with a tape to which a spring tension scale is affixed, and which is positioned as if buttock circumference were being measured. Two hundred grams of tension are applied to the tape when measuring subjects in the undergarment layer and 600 grams are applied to the other layers of clothing. The depth is measured by placing the blades of the caliper on top of the tape. The subject stands erect with heels together and the weight distributed equally on both feet.

BUTTOCK DEPTH, UNCOMPRESSED

The horizontal depth of the torso at the level of the clothed buttock point landmarks is measured with a beam caliper. The recorder helps place and stabilize the fixed blade of the caliper on the landmarks so the clothing will not be compressed. The subject stands erect with the heels together and the weight distributed equally on both feet.

BUTTOCK HEIGHT

The vertical distance between a standing surface and the level of the clothed buttock point (right lateral) landmark is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

BUTTOCK-KNEE LENGTH

The horizontal distance between a buttock plate placed at the posterior point on either buttock and the anterior point of the clothed right knee is measured with an anthropometer. The clothing is not compressed. The subject sits erect. The thighs are horizontal and parallel to each other and the knees flexed 90 degrees with the feet in line with the thighs.

BUTTOCK-POPLITEAL LENGTH

The horizontal distance between a buttock plate placed at the posterior point on either buttock and the back of the clothed right knee (at the dorsal junction of the calf and thigh) is measured with an anthropometer. The clothing is allowed to drape naturally and is not compressed with the anthropometer while measuring. The subject sits erect. The thighs are horizontal and parallel to each other and the knees flexed 90 degrees with the feet in line with the thighs.

CALF BREADTH

The breadth of the right calf at the level of the clothed calf landmark is measured with a beam caliper. The clothing is allowed to drape naturally, and is not compressed with the caliper during measurement. The measurement is made perpendicular to the long axis of the leg. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF CIRCUMFERENCE

The circumference of the right calf at the level of the clothed calf point landmark is measured with a tape. The tape is perpendicular to the long axis of the leg. Eighty grams of tension, as determined by a spring tension scale, is applied to the tape. The clothing is compressed only by the application of the tape. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF DEPTH

The depth of the right calf at the level of the clothed calf point landmark is measured with a beam caliper. The clothing is allowed to drape naturally, and is not compressed with the caliper during measurement. The measurement is made perpendicular to the long axis of the leg. The subject stands erect with the heels approximately 10 cm apart and the weight distributed equally on both feet.

CALF HEIGHT

The vertical distance between a standing surface and the level of the clothed calf point landmark is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

CHEST BREADTH

The maximum horizontal breadth of the chest at the level of the clothed chest point landmark is measured with a beam caliper. The clothing is not compressed. The subject stands erect looking straight ahead with the heels together and the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

CHEST CIRCUMFERENCE

The maximum horizontal circumference of the chest at the level of the clothed chest point landmark is measured with a tape. Eighty grams of tension, as determined by an affixed spring tension scale, is applied to the tape. The clothing is compressed only by the application of the tape. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST DEPTH

The horizontal distance between the chest and the back at the level of the clothed chest point landmark is measured with a beam caliper. The clothing is not compressed. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST DEPTH AT DELTOID POINT, COMPRESSED

The horizontal distance between the chest and the back at the level of the clothed deltoid landmark is measured with a beam caliper. The clothing is compressed with 200 grams of tension applied to the undergarment layer and 600 grams to the remaining layers. The tape passes around the chest and arms at the level of the clothed deltoid landmarks as if to measure shoulder circumference, compressed. The blades of the beam caliper are placed on top of the tape. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST DEPTH AT DELTOID POINT, UNCOMPRESSED

The horizontal distance between the chest and the back at the level of the clothed deltoid landmarks is measured with a beam caliper. The clothing is not compressed. The recorder helps position and stabilize the fixed blade of the caliper to help prevent compression of the material during measurement. The subject stands erect looking straight ahead. The shoulder and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CHEST HEIGHT

The vertical distance between a standing surface and the clothed chest point landmark is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

CROTCH HEIGHT

The vertical distance between the standing surface and the clothed crotch is measured with an anthropometer. The material in the crotch hangs naturally and is not compressed by the anthropometer during measurement. The subject stands erect looking straight ahead. The heels are as close together as possible considering the constraints of the clothing, and the weight is distributed equally on both feet.

DELTOID POINT HEIGHT

The vertical distance between the standing surface and the clothed deltoid point landmark on the right sleeve is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together and the weight is distributed equally on both feet.

ECTOORBITALE - TOP OF HEAD

The vertical distance between the clothed ectoorbitale landmark and the horizontal plane tangent to the top of the head is measured using a headboard and a headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The subject is positioned and the headboard adjusted so the back plate of the headboard firmly touches the most posterior portion of the clothed head and the top plate firmly touches the top of the clothed head. Measurement is made from the top plate to the ectoorbitale landmark. Where necessary, small adhesive pads are placed around a screw or snap on the back of the helmet to make it easier for subjects to hold their heads steady.

ELBOW BREADTH

The breadth of the clothed right elbow is measured at the level of the lateral and medial epicondyles of the humerus with a beam caliper, when the clothing is light enough to permit palpation of these points. For heavier clothing, the measurement is taken at the level of the olecranon-center landmark on the sleeve. The measurement is taken perpendicular to the long axis of the arm. The subject stands with the arm straight and held away from the body at 45 degrees with the palm facing forward. The clothing is allowed to hang naturally and is not compressed by the caliper during measurement.

ELBOW CIRCUMFERENCE

The circumference of the clothed right elbow in a plane perpendicular to the long axis of the arm is measured with a tape at the level of the olecranon landmark on the sleeve. Eighty grams of tension, as determined by an affixed spring tension scale, is applied to the tape. The subject stands with the arm straight and held away from the body at 45 degrees with the palm facing forward. The clothing is allowed to hang naturally and is compressed only by the application of the tape during measurement.

ELBOW DEPTH

The depth of the clothed elbow is measured at the clothed olecranon landmark on the sleeve with a beam caliper. The measurement is taken perpendicular to the long axis of the arm. The subject stands with the arm straight and held away from the body at 45 degrees with the palm facing forward. The material in the sleeve is allowed to hang naturally and is not compressed by the caliper during measurements.

EYE HEIGHT, SITTING

The vertical distance between a sitting surface and the clothed ectocanthus landmark is measured with an anthropometer. The subject sits erect with the head in the Frankfort plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are horizontal and parallel to each other and the knees are flexed 90 degrees with the feet in line with the thighs. The measurement is taken at the maximum point of quiet respiration.

FOOT (BOOT) BREADTH, HORIZONTAL

The maximum breadth of the right boot is measured on a footbox scale. The subject stands with each foot in a footbox and the weight equally distributed on both feet. The heel of the right boot lightly touches the back of the box, and the side of the boot at the area of the fifth metatarsophalangeal protrusion lightly touches the side of the box. The medial side of the boot is parallel to the long axis of the box. A block is placed against the boot at the widest point below the base of the laces to establish the measurement on the scale.

FOOT (BOOT) LENGTH

The maximum length of the right boot is measured on a footbox scale. The subject stands with the right boot in a footbox and the weight distributed equally on both feet. The heel of the right boot lightly touches the back of the box, and the side of the boot at the area of the fifth metatarsophalangeal protrusion lightly touches the side of the box. The medial side of the boot is parallel to the long axis of the box. A block is placed against the anterior tip of the boot to establish the measurement on the scale.

FOREARM BREADTH, FLEXED

The breadth of the clothed flexed right forearm is measured with a beam caliper at the level of the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. The clothing is not compressed. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

FOREARM CIRCUMFERENCE, FLEXED

The circumference of the clothed flexed right forearm is measured with a tape passing across the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. Eighty grams of tension, as determined by an affixed spring tension scale, is applied to the tape. The clothing is compressed only by the application of the tape during measurement. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

FOREARM DEPTH, FLEXED

The depth of the clothed flexed right forearm is measured with a beam caliper at the level of the crease at the juncture between the upper arm and the forearm. The measurement is made in a plane perpendicular to the long axis of the forearm. The clothing is not compressed. The subject stands with the upper arm extended forward horizontally, the elbow flexed 90 degrees, and the tightly clenched fist held facing the head.

GLABELLA-HELMET RIM

The horizontal distance from the nude glabella landmark to the anterior rim of the helmet in the midsagittal plane is measured with a sliding caliper with the sliding blade reversed. The measurement is read on the depth scale. The head is positioned in the Frankfort plane.

HAND BREADTH

The breadth of the gloved right hand between the clothed metacarpale II and clothed metacarpale V landmarks is measured with a sliding caliper. The glove is not compressed. The subject places the palm on a table, the fingers together and the thumb held away. The middle finger is parallel to the long axis of the forearm. The two distal phalanges of the fingers lie on a flat surface 8 mm higher than the table.

HAND CIRCUMFERENCE

The circumference of the gloved right hand is measured with a tape passing over the clothed landmarks at metacarpale II and metacarpale V. The subject places the palm on a table, the fingers together, and the thumb held away. The middle finger is parallel to the long axis of the forearm. The two distal phalanges

of the fingers lie on a flat surface 8 mm higher than the table. Eighty grams of tension, as determined with an affixed tension spring tension scale, is applied to the tape. The glove is compressed only by the application of the tape during measurement.

HAND LENGTH

The length of the right hand between the clothed stylion landmark on the wrist and the tip of the glove on the middle finger is measured with a beam caliper. The subject places the palm on a table, the fingers together, and the thumb held away. The middle finger is parallel to the long axis of the forearm. The two distal phalanges of the fingers lie on a flat surface 8 mm higher than the table.

HAND THICKNESS

The thickness of the gloved right hand at the third metacarpophalangeal joint is measured with a sliding caliper. The glove is not compressed. The subject extends the right arm forward with the palm facing down.

HEAD (HELMET) BREADTH

The maximum horizontal breadth of the clothed head above the plane of the attachment of the ears is measured with a spreading caliper. On helmets the measurement is made above the ear cups.

HEAD (HELMET) CIRCUMFERENCE

The maximum circumference of the clothed head above the ears (or above the ear cups in the case of a helmet) is measured with a tape.

HEAD (HELMET) LENGTH

The distance from the nude glabella landmark between the browridges to the posterior point on the back of the clothed head is measured with a spreading caliper. On helmets, the distance is measured along the sagittal plane from the edge of the front rim to the most protruding point on the back of the helmet.

HEEL BREADTH

The maximum horizontal distance between the medial and lateral points on the inside and outside of the right heel of the boot, at or posterior to the clothed lateral malleolus landmark, is measured with a Holtain caliper. The measurement is taken at the most protruding points of the curvature of the heel. On the leather combat boot the widest point lies on the leather above the heel. The widest point on the GVO boot is found on the heel of the boot just above the surface of the floor. The subject stands with the feet about 10 cm apart and the weight distributed equally on both.

HELMET RIM-TOP OF HEAD

The vertical distance between the helmet rim at the front center of the helmet and the horizontal plane tangent to the top of the helmet is measured using a headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the helmet touches the vertical plate of the headboard, and the top of the helmet touches the horizontal overhead plate.

HIP BREADTH; COMPRESSED

The horizontal distance between the clothed lateral buttock landmarks is measured with a beam caliper. The clothing is compressed with a tape to which a spring tension scale has been affixed, which is positioned as if to measure buttock circumference. Two hundred grams of tension are applied to the tape when measuring subjects in the undergarment layer and 600 grams are applied to the other layers of clothing. The breadth is measured by placing the blades of the beam caliper on top of the tape. The subject stands erect with the heels together and the weight distributed equally on both feet.

HIP BREADTH, UNCOMPRESSED

The horizontal distance between the clothed lateral buttock point landmarks is measured with a beam caliper. The clothing is allowed to drape naturally and is not compressed with the blades of the caliper during measurement. The recorder helps position and stabilize the fixed blade so as not to compress the clothing. The subject stands erect with the heels together and the weight distributed equally on both feet.

KNEE BREADTH

The breadth of the clothed right knee at the level of the clothed midpatella landmark is measured on uncompressed clothing with a beam caliper. The measurement is made perpendicular to the long axis of the leg. The clothing is allowed to hang naturally and is not compressed with the caliper during measurement. The subject stands erect with the feet about 10 cm apart and the weight distributed equally on both feet.

KNEE CIRCUMFERENCE

The horizontal circumference of the clothed right knee at the level of the clothed midpatella landmark is measured with a tape with an affixed spring tension scale. Eighty grams of tension is applied to the tape. The clothing is allowed to hang naturally and is compressed only by the application of the tape during measurement.

KNEE DEPTH

The depth of the right knee at the level of the clothed midpatella landmark is measured with a beam caliper. The measurement is made perpendicular to the long axis of the leg. The clothing is allowed to hang naturally and is not compressed with the caliper during measurement. The subject stands erect with the feet about 10 cm apart and the weight distributed equally on both feet.

KNEE HEIGHT, MIDPATELLA

The vertical distance between a standing surface and the clothed midpatella landmark of the right leg is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

KNEE HEIGHT, SITTING

The vertical distance between a footrest surface and the clothed suprapatella landmark at the top of the clothed right knee is measured with an anthropometer. The subject sits with the thighs horizontal and parallel to each other, the knees flexed 90 degrees, and the feet in line with the thighs. The size of the ball bearing is not believed to affect the measurement.

LATERAL FEMORAL EPICONDYLE HEIGHT

The vertical distance between a standing surface and the clothed lateral femoral epicondyle landmark is measured with an anthropometer. The subject stands erect with the heels together and the weight distributed equally on both feet.

LATERAL MALLEOLUS HEIGHT

The vertical distance between a standing surface and the clothed lateral malleolus landmark is measured with a headboard gauge (a modified sliding caliper). The subject stands erect with the heels together and the weight distributed equally on both feet.

MENTON-SELLION LENGTH

The distance between the nude menton landmark projected to the bottom of the chin piece of the mask and the nude sellion landmark projected onto the outside of the mask is measured with a sliding caliper. The nude sellion landmark is sighted through the lenses of the mask and projected onto the mask surface. The nude menton landmark is approximated as closely as possible onto the bottom of the chin piece. The teeth are lightly occluded.

MENTON-TOP OF HEAD

The vertical distance between the nude menton landmark at the bottom of the chin or facemask and the horizontal plane tangent to the top of the clothed head is measured using a headboard and headboard gauge. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard, and the top of the head touches the horizontal overhead plate.

MIDSHOULDER HEIGHT

The vertical distance between a standing surface and the clothed midshoulder landmark is measured with an anthropometer. The clothing is not compressed. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

MIDSHOULDER HEIGHT, SITTING

The vertical distance between a sitting surface and the clothed midshoulder landmark is measured with an anthropometer. The clothing is not compressed. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is taken at the maximum point of quiet respiration.

MIDTHIGH BREADTH

The breadth of the right thigh at the level of the clothed midthigh landmark is measured with a beam caliper. The clothing is allowed to hang naturally and the blades just touch the cloth without compressing it. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the clothing between the thighs does not touch.

MIDTHIGH CIRCUMFERENCE

The circumference of the right thigh at the level of the clothed midthigh landmark is measured with a tape to which a spring scale has been affixed. The clothing is allowed to hang naturally and is compressed only by the application of the tape during measurement. Eighty grams of tension is applied to the tape. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight equally distributed on both feet. The legs are spread apart just enough so the clothing between the thighs does not touch.

MIDTHIGH DEPTH

The depth of the right thigh at the level of the clothed midthigh landmark is measured with a beam caliper. The clothing is allowed to hang naturally, and the blades just touch the cloth without compressing it. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the clothing between the thighs does not touch.

MIDTHIGH HEIGHT

The vertical distance between a standing surface and the level of the clothed midthigh landmark is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet.

NECK BREADTH

The breadth of the neck is measured at the level of the clothed infrathyroid landmark with a beam caliper. The blades just touch the clothing without compressing it. The measurement is taken perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane.

NECK CIRCUMFERENCE

The circumference of the neck at the level of the clothed infrathyroid landmark is measured with a tape to which a spring tension scale has been affixed. Eighty grams of tension is applied to the tape. The plane of the measurement is perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane. The shoulders and upper extremities are relaxed.

NECK DEPTH

The depth of the neck is measured at the level of the clothed infrathyroid landmark with a beam caliper. The blades just touch the clothing without compressing it. The measurement is taken perpendicular to the long axis of the neck. The subject stands erect with the head in the Frankfort plane. The shoulders and upper extremities are relaxed.

NECK HEIGHT, LATERAL

The vertical distance between a standing surface and the level of the clothed lateral neck landmark is measured with an anthropometer. The subject stands erect with the head in the Frankfort plane. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

POPLITEAL HEIGHT

The vertical distance from a footrest surface to the level of the dorsal juncture of the clothed right calf and thigh is measured with an anthropometer. The blade just touches the clothing without compressing it. The subject sits with the thighs horizontal and parallel to each other, the feet in line with the thighs, and the knees flexed 90 degrees.

RADIALE-STYLION LENGTH

This measurement is unchanged by the addition of clothing, and is not measured in the clothed condition.

SELLION-BACK OF HEAD

The horizontal distance between the nude sellion landmark and the vertical plane tangent to the back of the helmet or balaclava is measured using a headboard and headboard gauge. The subject stands under

the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard, and the top of the head touches the horizontal overhead plate. When wearing the aviator's helmet, the measurement is taken as the distance from the visor at the level of the sellion landmark. When wearing the mask, the sellion landmark is sighted through the mask lenses.

SELLION-TOP OF HEAD

The vertical distance between the nude sellion landmark and the horizontal plane tangent to the top of the helmet or balaclava is measured. The subject stands under the headboard with the head in the Frankfort plane. The back of the head touches the vertical plate of the headboard, and the top of the head touches the horizontal overhead plate. When wearing the aviator's helmet, the measurement is taken as the distance from the visor at the level of the sellion landmark. When wearing the mask, the sellion landmark is sighted through the mask lenses.

SHOULDER CIRCUMFERENCE, COMPRESSED

The horizontal circumference of the shoulders at the level of the clothed deltoid landmarks is measured with a tape to which a spring tension scale has been affixed. Two hundred grams of tension is applied to the tape for the undergarment layer of clothing, and 600 grams is applied for the other layers. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed with the palms facing the thighs. The measurement is taken at the maximum point of quiet respiration.

SHOULDER CIRCUMFERENCE, UNCOMPRESSED

The horizontal circumference of the shoulders at the level of the clothed deltoid landmarks is measured with a tape to which a spring tension scale has been affixed. Eighty grams of tension is applied to the tape. The clothing is allowed to hang naturally and is compressed only by the application of the tape during measurement. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed with the palms facing the thighs. The measurement is taken at the maximum point of quiet respiration.

SITTING HEIGHT

The vertical distance between a sitting surface and the top of the clothed head or helmet is measured with an anthropometer. The subject sits erect with the head in the Frankfort plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are horizontal and parallel to each other, and the knees are flexed 90 degrees with the feet in line with the thighs. The measurement is made at the maximum point of quiet respiration.

STATURE

The vertical distance from a standing surface to the top of the clothed head or helmet is measured with an anthropometer. The subject stands erect with the head in the Frankfort plane. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

THIGH BREADTH, CROTCH

The breadth of the clothed right thigh at the level of the crotch of the clothing is measured with a beam caliper. The blades just touch the clothing without compressing the material. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the clothing does not touch between the thighs.

THIGH CIRCUMFERENCE, CROTCH

The circumference of the clothed right thigh at the level of the crotch of the clothing is measured with a tape to which a spring tension scale has been affixed. Eighty grams of tension is applied to the tape. The measurement is made perpendicular to the long axis of the thigh. The clothing is compressed only by the application of the tape during measurement. The subject stands erect with the weight equally distributed on both feet. The legs are spread apart just enough so that the clothing between the thighs does not touch.

THIGH CLEARANCE

The vertical distance between a sitting surface and the highest point on the top of the clothed right thigh is measured with an anthropometer. The blade just touches the clothing without compressing the material. The subject sits erect with the thighs horizontal, parallel to each other, knees flexed 90 degrees, and the feet in line with the thighs.

THIGH DEPTH, CROTCH

The depth of the clothed right thigh at the level of the crotch of the clothing is measured with a beam caliper. The blades just touch the clothing without compressing the material. The measurement is made perpendicular to the long axis of the thigh. The subject stands erect with the weight distributed equally on both feet. The legs are spread apart just enough so that the clothing between the thighs does not touch.

TROCHANTERIC HEIGHT

The vertical distance between a standing surface and the level of the clothed trochanterion landmark is measured with an anthropometer. The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet.

VERTICAL TRUNK CIRCUMFERENCE

The vertical circumference of the clothed torso is measured with a tape to which a spring tension scale has been attached. The tape passes between the clothed buttocks, over the clothed right bustpoint landmark on women or the nipple (thelion) on men, and across the clothed midshoulder landmark. On thinner layers, notably the undergarment layer, the tape passes to the right of the clothed genitalia. On heavier layers, the tape passes through the clothed crotch. Eighty grams of tension is applied to the tape. The clothing is compressed only by the application of the tape during measurement. The subject stands erect looking straight ahead with the arms hanging relaxed at the side. The heels are together with the weight distributed equally on both feet. The measurement is taken at the midpoint of quiet respiration.

WAIST BREADTH (OMPHALION)

The horizontal breadth of the clothed waist at the level of the clothed waist (omphalion) landmarks, right and left is measured with a beam caliper. The blades just touch the clothing without compressing the material. The subject stands erect looking straight ahead with the arms relaxed at the sides. The heels are together with the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

WAIST CIRCUMFERENCE (OMPHALION)

The horizontal circumference of the clothed waist at the level of the clothed omphalion landmarks (anterior, posterior, right, and left) is measured with a tape to which a spring tension scale has been affixed. Eighty grams of tension is applied to the tape. The clothing is compressed only by the application of the tape during measurement. The subject stands erect looking straight ahead with the arms relaxed at the sides. The heels are together with the weight distributed equally on both feet. The measurement is made at the maximum point of quiet respiration.

WAIST DEPTH (OMPHALION)

The horizontal depth of the clothed waist at the level of the clothed omphalion landmarks (anterior and posterior) is measured with a beam caliper. The recorder helps position and stabilize the fixed blade of the caliper to avoid compressing the clothing. The subject stands erect looking straight ahead with the arms relaxed at the sides. The heels are together with the weight distributed equally on both feet. The measurement is taken at the maximum point of quiet respiration.

WAIST HEIGHT (OMPHALION)

The vertical distance between a standing surface and the clothed anterior omphalion landmark is measured with an anthropometer. The subject stands erect looking straight ahead with the arms relaxed at the sides. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities are relaxed. The measurement is made at the maximum point of quiet respiration.

WEIGHT

The weight of the clothed subject is taken to the nearest tenth of a kilogram on a beam scale. The subject stands on the platform of a scale facing the beam with the weight distributed equally on both feet.

WRIST BREADTH

The breadth of the clothed wrist is measured with a sliding caliper at the intersection of the hand with the wrist. The location of the intersection is determined by asking the clothed subject to bend the wrist. The clothing is not compressed. The measurement is taken perpendicular to the long axis of the forearm. The subject stands with the upper arm relaxed, the elbow flexed 90 degrees, the forearm extended forward horizontally and the palm facing upward.

WRIST CIRCUMFERENCE

The circumference of the clothed wrist is measured with a tape to which a spring scale has been affixed. The tape passes over the clothed stylion landmark on the wrist and the measurement is made perpendicular to the long axis of the forearm. Eighty grams of tension is applied to the tape. The clothing is compressed only by the application of the tape during measurement. The subject stands with the upper arm relaxed, the elbow flexed 90 degrees, the forearm extended forward horizontally, and the palm facing upward.

WRIST DEPTH

The depth of the clothed wrist is measured with a sliding caliper at the intersection of the hand with the wrist. The location of the intersection is determined by asking the clothed subject to bend the wrist. The clothing is not compressed. The measurement is taken perpendicular to the long axis of the forearm. The subject stands with the upper arm relaxed, the elbow flexed 90 degrees, the forearm extended forward horizontally and the palm facing upward.

APPENDIX E

MEAN ABSOLUTE DIFFERENCES BETWEEN INITIAL AND REPEAT MEASUREMENTS BY CLOTHING LAYER

TABLE E-1

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
GROUND SOLDIER ENSEMBLE
FEMALES
weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	3	5	2	4	6
Acromion Height	4	4	4	5	5
Acromion-Radiale Length	2	NA	NA	NA	NA
Ankle Breadth	1	0	1	3	NA
Ankle Circumference	1	1	1	4	NA
Ankle Depth	0	2	1	4	NA
Ankle Height	1	2	1	1	NA
Axilla (Scye) Height	3	5	7	7	8
Ball of Foot Circumference	1	1	1	2	NA
Ball of Foot Length	2	1	1	2	NA
Biacromial Breadth	1	5	3	10	4
Biceps Breadth, Flexed	3	2	5	2	NA
Biceps Circumference, Flexed	2	1	3	9	NA
Biceps Depth, Flexed	1	3	9	5	NA
Bideltoid Breadth, Compressed	NA	3	2	3	2
Bideltoid Breadth, Uncompressed	3	2	4	10	6
Bimalleolar Breadth	1	1	2	3	NA
Bitragion *(Ear* Cup) Breadth	1	NA	1	NA	NA
Buttock Circumference, Compressed	NA	6	5	6	NA
Buttock Circumference, Uncompressed	1	6	2	9	NA
Buttock Depth, Compressed	NA	8	4	6	NA
Buttock Depth, Uncompressed	6	6	8	6	NA
Buttock Height	1	2	4	1	NA
Buttock-Knee Length	3	5	4	4	3
Buttock-Popliteal Length	4	4	7	9	4
Calf Breadth	2	2	4	5	NA
Calf Circumference	1	1	5	5	NA
Calf Depth	0	0	6	2	NA
Calf Height	1	2	2	4	NA
Chest Breadth	2	6	3	6	6
Chest Circumference	6	4	5	5	6
Chest Depth	1	2	6	7	4
Chest Depth - Deltoid Point, Comp	NA	4	6	5	5
Chest Depth - Deltoid Point, Uncomp	2	2	4	6	6
Chest Height	4	3	5	8	4
Crotch Height	4	4	6	2	NA
Deltoid Point Height	3	3	2	4	3
Ectoorbitale-Top of Head	2	NA	3	4	NA

TABLE E-1 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Elbow Breadth	3	NA	5	7	NA
Elbow Circumference	2	NA	3	6	NA
Elbow Depth	1	NA	4	7	NA
Eye Height, Sitting	3	3	6	3	NA
Foot Breadth Horizontal	1	1	1	1	NA
Foot Length	1	0	0	1	NA
Forearm Breadth, Flexed	1	NA	4	6	NA
Forearm Circumference, Flexed	3	NA	3	6	NA
Forearm Depth, Flexed	2	NA	7	7	NA
Glabella-Helmet Rim	NA	NA	1	0	NA
Hand Breadth	1	NA	NA	1	NA
Hand Circumference	1	NA	NA	3	NA
Hand Length	1	NA	NA	5	NA
Hand Thickness	1	NA	NA	2	NA
Head (Helmet) Breadth	1	NA	1	NA	NA
Head (Helmet) Length	1	NA	0	NA	NA
Head (Helmet) Circumference	2	NA	1	NA	NA
Heel Breadth	1	1	1	1	NA
Helmet Rim-Top of Head	NA	NA	3	1	NA
Hip Breadth, Compressed	NA	2	3	5	NA
Hip Breadth, Uncompressed	2	3	6	5	NA
Knee Breadth	1	NA	6	2	NA
Knee Circumference	2	NA	4	7	NA
Knee Depth	1	NA	9	7	NA
Knee Height, Midpatella	2	2	4	6	NA
Knee Height, Sitting	1	1	2	2	NA
Lateral Femoral Epicondyle Height	1	1	2	2	NA
Lateral Malleolus Height	1	1	0	2	NA
Menton-Sellion Length	2	NA	2	2	NA
Menton-Top of Head	1	NA	3	1	NA
Midshoulder Height	2	2	4	4	3
Midshoulder Height, Sitting	2	4	2	8	4
Midthigh Breadth	1	NA	4	5	NA
Midthigh Circumference	4	NA	8	9	NA
Midthigh Depth	3	NA	3	5	NA
Midthigh Height	1	1	3	3	NA
Neck Breadth	2	NA	2	5	6
Neck Circumference	2	NA	5	4	5
Neck Depth	1	NA	1	5	8
Neck Height, Lateral	2	2	3	4	3
Popliteal Height	0	2	6	4	NA
Radiale-Stylion Length	2	NA	NA	NA	NA
Sellion-Back of Head	1	NA	1	1	NA
Sellion-Top of Head	2	NA	2	2	NA

TABLE E-1 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Shoulder Circumference, Compressed	NA	5	8	6	6
Shoulder Circumference, Uncompressed	4	5	2	6	9
Sitting Height	2	1	3	1	NA
Stature	2	2	3	1	4
Thigh Breadth, Crotch	3	NA	3	4	NA
Thigh Circumference, Crotch	3	NA	4	6	NA
Thigh Clearance	2	NA	2	2	NA
Thigh Depth, Crotch	3	NA	4	6	NA
Trochanteric Height	2	2	2	2	NA
Vertical Trunk Circumference	6	9	6	9	11
Waist Breadth	2	4	4	8	4
Waist Circumference, Omphalion	2	6	6	16	3
Waist Depth	3	5	5	3	2
Waist Height, Omphalion	3	3	2	3	2
Weight	0	0	1	0	0
Wrist Breadth	1	NA	2	1	NA
Wrist Circumference	1	NA	2	2	NA
Wrist Depth	1	NA	2	2	NA

TABLE E-2

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
GROUND SOLDIER ENSEMBLE
MALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	3	3	2	4	4
Acromion Height	3	3	4	4	2
Acromion-Radiale Length	2	NA	NA	NA	NA
Ankle Breadth	1	0	1	4	NA
Ankle Circumference	1	3	2	8	NA
Ankle Depth	0	0	1	4	NA
Ankle Height	1	1	2	4	NA
Axilla (Scye) Height	4	5	4	8	4
Ball of Foot Circumference	1	1	1	2	NA
Ball of Foot Length	2	2	1	2	NA
Biacromial Breadth	3	4	2	8	5
Biceps Breadth, Flexed	2	2	4	6	NA
Biceps Circumference, Flexed	2	4	7	7	NA
Biceps Depth, Flexed	1	3	4	4	NA
Bideltoid Breadth, Compressed	NA	4	3	7	6
Bideltoid Breadth, Uncompressed	3	7	4	7	4
Bimalleolar Breadth	1	0	1	3	NA
Bitragion (Ear Cup) Breadth	1	NA	1	NA	NA
Buttock Circumference, Compressed	NA	5	7	4	NA
Buttock Circumference, Uncompressed	3	4	7	5	NA
Buttock Depth, Compressed	NA	1	4	4	NA
Buttock Depth, Uncompressed	4	4	12	16	NA
Buttock Height	1	3	2	3	NA
Buttock-Knee Length	2	4	4	8	9
Buttock-Popliteal Length	3	3	5	6	10
Calf Breadth	1	1	6	6	NA
Calf Circumference	1	1	6	22	NA
Calf Depth	1	1	11	6	NA
Calf Height	0	2	2	8	NA
Chest Breadth	2	5	9	4	6
Chest Circumference	9	8	13	20	7
Chest Depth	2	6	4	13	6
Chest Depth - Deltoid Point, Comp	NA	4	3	6	6
Chest Depth - Deltoid Point, Uncomp	2	4	5	9	5
Chest Height	6	3	4	6	4
Crotch Height	4	4	3	14	NA
Deltoid Point Height	4	5	3	7	4
Ectoorbitale-Top of Head	1	NA	4	1	NA

TABLE E-2 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Elbow Breadth	1	NA	4	13	NA
Elbow Circumference	1	NA	5	11	NA
Elbow Depth	1	NA	6	8	NA
Eye Height, Sitting	5	5	4	4	NA
Foot Breadth Horizontal	1	1	1	1	NA
Foot Length	1	1	1	2	NA
Forearm Breadth, Flexed	2	NA	5	5	NA
Forearm Circumference, Flexed	3	NA	9	6	NA
Forearm Depth, Flexed	2	NA	5	5	NA
Glabella-Helmet Rim	NA	NA	1	1	NA
Hand Breadth	0	NA	NA	3	NA
Hand circumference	3	NA	NA	3	NA
Hand Length	2	NA	NA	3	NA
Hand Thickness	0	NA	NA	2	NA
Head (Helmet) Breadth	I	NA	0	NA	NA
Head (Helmet) Length	1	NA	0	NA	NA
Head (Helmet) Circumference	1	NA	2	NA	NA
Heel Breadth	1	1	1	1	NA
Helmet Rim-Top of Head	NA	NA	3	2	NA
Hip Breadth, Compressed	NA	2	4	4	NA
Hip Breadth, Uncompressed	3	3	13	6	NA
Knee Breadth.	1	NA	5	11	NA
Knee Circumference	3	NA	8	18	NA
Knee Depth	0	NA	8	6	NA
Knee Height. Midpatella	1	2	5	8	NA
Knee Height, Sitting	0	2	2	3	NA
Lateral Femoral Epicondyle Height	1	1	1	7	NA
Lateral Malleolus Height	1	1	2	3	NA
Menton-Sellion Length	1	NA	2	1	NA
Menton-Top of Head	1	NA	5	3	NA
Midshoulder Height	3	4	3	5	4
Midshoulder Height, Sitting	3	5	3	7	3
Midthigh Breadth	3	NA	5	6	NA
Midthigh Circumference	2	NA	7	15	NA
Midthigh Depth	2	NA	7	6	NA
Midthigh Height	1	2	4	10	NA
Neck Breadth	2	NA	4	7	5
Neck Circumference	2	NA	4	5	3
Neck Depth	1	NA	2	11	5
Neck Height. Lateral	2	1	4	1	4
Popliteal Height	1	1	12	6	NA
Radiale-Stylion Length	3	NA	NA	NA	NA
Sellion-Back of Head	1	NA	1	1	NA
Sellion-Top of Head	2	NA	2	3	NA

TABLE E-2 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Shoulder Circumference, Compressed	NA	6	5	13	11
Shoulder Circumference, Uncompressed	11	6	8	11	10
Sitting Height	3	3	3	8	NA
Stature	4	2	3	4	4
Thigh Breadth, Crotch	5	NA	4	2	NA
Thigh Circumference, Crotch	4	NA	7	7	NA
Thigh Clearance	I	NA	3	5	NA
Thigh Depth, Crotch	3	NA	7	13	NA
Trochanteric Height	4	4	4	3	NA
Vertical Trunk Circumference	8	10	6	21	9
Waist Breadth	4	5	8	8	5
Waist Circumference, Omphalion	4	10	3	15	4
Waist Depth	3	3	16	14	3
Waist Height, Omphalion	6	5	6	3	3
Weight	1	0	1	1	1
Wrist Breadth	1	NA	1	2	NA
Wrist Circumference	2	NA	2	5	NA
Wrist Depth	0	NA	2	4	NA

TABLE E-3

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
AVIATOR WARM WEATHER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height. Sitting	3	5	5	2	2	2
Acromion Height	4	4	3	2	3	4
Acromion-Radiale Length	2	NA	NA	NA	NA	NA
Ankle Breadth	1	0	3	NA	NA	2
Ankle circumference	1	1	3	NA	NA	6
Ankle Depth	0	2	9	NA	NA	3
Ankle Height	1	2	4	NA	NA	2
Axilla (Scye.) Height	3	5	2	5	9	10
Ball of Foot circumference	1	1	NA	NA	NA	NA
Ball of Foot Length	2	1	NA	NA	NA	NA
Biacromial Breadth	1	5	1	3	5	5
Biceps Breadth, Flexed	3	2	6	5	NA	3
Biceps Circumference, Flexed	2	1	3	3	NA	8
Biceps Depth, Flexed	1	3	5	3	NA	3
Bideltoid Breadth, Compressed	NA	3	1	4	NA	4
Bideltoid Breadth. Uncomp.	3	2	4	3	NA	7
Bimalleolar Breadth	1	1	3	NA	NA	5
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	NA	NA
Buttock Circumference, Comp.	NA	6	4	NA	5	4
Buttock Circumference, Uncomp.	1	6	3	NA	3	5
Buttock Depth, Compressed	NA	8	2	NA	3	3
Buttock Depth, Uncompressed	6	6	4	NA	5	8
Buttock Height	1	2	3	NA	5	2
Buttock-Knee Length	3	5	4	3	NA	3
Buttock-Popliteal Length	4	4	5	6	NA	4
Calf Breadth	2	2	7	NA	NA	4
Calf Circumference	1	1	7	NA	NA	8
Calf Depth	0	0	8	NA	NA	8
Calf Height	1	2	2	NA	NA	1
Chest Breadth	2	6	3	6	5	4
Chest Circumference	6	4	6	7	3	5
Chest Depth	1	2	10	6	4	6
Chest Depth - Delt. Pt., Comp.	NA	4	4	4	2	3
Chest Depth - Delt. Pt., Uncomp.	2	2	4	5	4	5
Chest Height	4	3	3	2	4	4
Crotch Height	4	4	4	NA	3	5
Deltoid Point Height	3	3	3	3	4	4
Ectoorbitale-Top of Head	2	NA	2	NA	NA	4

TABLE E-3 (Continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Elbow Breadth	3	NA	3	2	NA	6
Elbow Circumference	2	NA	2	6	NA	9
Elbow Depth	1	NA	6	5	NA	8
Eye Height, Sitting	3	3	4	NA	NA	7
Foot Breadth Horizontal	1	1	NA	NA	NA	NA
Foot Length	1	0	NA	NA	NA	NA
Forearm Breadth, Flexed	1	NA	4	3	NA	5
Forearm Circumference, Flexed	3	NA	4	7	NA	8
Forearm Depth, Flexed	2	NA	6	7	NA	3
Glabella-Helmet Rim	NA	NA	0	NA	NA	1
Hand Breadth	1	NA	2	NA	NA	NA
Hand Circumference	1	NA	1	NA	NA	NA
Hand Length	1	NA	2	NA	NA	NA
Hand Thickness	1	NA	2	NA	NA	NA
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA
Head (Helmet) Circumference	2	NA	NA	NA	NA	NA
Heel Breadth	1	1	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	2	NA	NA	3
Hip Breadth, Compressed	NA	2	3	NA	NA	3
Hip Breadth, Uncompressed	2	3	2	NA	NA	6
Knee Breadth	1	NA	6	NA	NA	5
Knee Circumference	2	NA	6	NA	NA	5
Knee Depth	1	NA	3	NA	NA	4
Knee Height. Midpatella	2	2	4	NA	NA	2
Knee Height, Sitting	1	1	3	NA	NA	2
Lateral Femoral Epicondyle Ht.	1	1	2	NA	NA	2
Lateral Malleolus Height	1	1	1	NA	NA	1
Menton-Sellion Length	2	NA	NA	NA	NA	1
Menton-Top of Head	1	NA	2	NA	NA	3
Midshoulder Height	2	2	2	3	4	5
Midshoulder Height. Sitting	2	4	3	2	3	6
Midthigh Breadth	1	NA	4	NA	NA	3
Midthigh Circumference	4	NA	5	NA	NA	6
Midthigh Depth	3	NA	3	NA	NA	7
Midthigh Height	1	1	2	NA	NA	4
Neck Breadth	2	NA	2	4	NA	4
Neck Circumference	2	NA	5	3	NA	4
Neck Depth	1	NA	3	1	NA	5
Neck Height. Lateral	2	2	2	2	1	4
Popliteal Height	0	2	5	NA	NA	2
Radiale-Stylion Length	2	NA	NA	NA	NA	NA
Sellion-Back of Head	1	NA	NA	NA	NA	1
Sellion-Top of Head	2	NA	1	NA	NA	2

TABLE E-3 (Continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Shoulder Circumference. Comp.	NA	5	2	6	8	7
Shoulder Circ., Uncomp.	4	5	4	2	4	6
Sitting Height	2	1	2	NA	NA	1
Stature	2	2	2	3	2	4
Thigh Breadth. Crotch	3	NA	4	NA	NA	3
Thigh Circumference, Crotch	3	NA	2	NA	5	5
Thigh Clearance	2	NA	2	NA	NA	3
Thigh Depth, Crotch	3	NA	5	NA	7	7
Trochanteric Height	2	2	2	NA	NA	2
Vertical Trunk Circumference	6	9	6	5	9	9
Waist Breadth	2	4	3	5	5	4
Waist Circumference, Omphalion	2	6	4	7	5	2
Waist Depth	3	5	6	7	4	6
Waist Height, Omphalion	3	3	1	1	2	3
Weight	0	0	0	0	0	0
Wrist Breadth	1	NA	3	1	NA	2
Wrist Circumference	1	NA	2	0	NA	2
Wrist Depth	1	NA	2	1	NA	3

TABLE E-4

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
AVIATOR WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	3	3	6	4	4	4
Acromion Height	3	3	3	4	4	4
Acromion-Radiale Length	2	NA	NA	NA	NA	NA
Ankle Breadth	1	0	9	NA	NA	4
Ankle Circumference	1	3	3	NA	NA	2
Ankle Depth	0	0	10	NA	NA	4
Ankle Height	1	1	3	NA	NA	3
Axilla (Scye) Height	4	5	8	10	7	4
Ball of Foot Circumference	1	1	NA	NA	NA	NA
Ball of Foot Length	2	2	NA	NA	NA	NA
Biacromial Breadth	3	4	2	3	5	9
Biceps Breadth, Flexed	2	2	4	9	NA	6
Biceps Circumference, Flexed	2	4	3	9	NA	7
Biceps Depth, Flexed	1	3	11	8	NA	11
Bideltoid Breadth. Compressed	NA	4	3	2	NA	4
Bideltoid Breadth, Uncomp.	3	7	3	1	NA	6
Bimalleolar Breadth	1	0	10	NA	NA	2
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	NA	NA
Buttock Circumference, Comp.	NA	5	6	NA	7	7
Buttock Circumference. Uncomp.	3	4	6	NA	5	10
Buttock Depth, Compressed	NA	1	3	NA	7	7
Buttock Depth. Uncompressed	4	4	4	NA	2	8
Buttock Height	1	3	2	NA	4	5
Buttock-Knee Length	2	4	5	8	NA	5
Buttock-Popliteal Length	3	3	13	15	NA	9
Calf Breadth	1	1	5	NA	NA	4
Calf Circumference	1	1	4	NA	NA	11
Calf Depth	1	1	15	NA	NA	8
Calf Height	0	2	1	NA	NA	2
Chest Breadth	2	5	9	8	7	7
Chest Circumference	9	8	11	8	8	7
Chest Depth	2	6	7	9	5	7
Chest Depth - Delt. Pt., Comp.	NA	4	6	7	3	5
Chest Depth - Delt. Pt., Uncomp.	2	4	3	6	5	4
Chest Height	6	3	3	6	5	3
Crotch Height	4	4	5	NA	8	8
Deltoid Point Height	4	5	5	4	4	3
Ectoorbitale-Top of Head	1	NA	3	NA	NA	1

TABLE E-4 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Elbow Breadth	1	NA	7	3	NA	2
Elbow Circumference	1	NA	3	9	NA	12
Elbow Depth	1	NA	7	10	NA	6
Eye Height. Sitting	5	5	6	NA	NA	3
Foot Breadth Horizontal	1	1	NA	NA	NA	NA
Foot Length	1	1	NA	NA	NA	NA
Forearm Breadth. Flexed	2	NA	5	9	NA	3
Forearm Circumference, Flexed	3	NA	3	5	NA	8
Forearm Depth, Flexed	2	NA	5	5	NA	2
Glabella-Helmet Rim	NA	NA	2	NA	NA	1
Hand Breadth	0	NA	0	NA	NA	NA
Hand Circumference	3	NA	1	NA	NA	NA
Hand Length	2	NA	2	NA	NA	NA
Hand Thickness	0	NA	2	NA	NA	NA
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA
Head (Helmet) Circumference	1	NA	NA	NA	NA	NA
Heel Breadth	1	1	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	1	NA	NA	3
Hip Breadth, Compressed	NA	2	3	NA	NA	8
Hip Breadth, Uncompressed	3	3	7	NA	NA	6
Knee Breadth	1	NA	6	NA	NA	5
Knee Circumference	3	NA	6	NA	NA	9
Knee Depth	0	NA	13	NA	NA	10
Knee Height, Midpatella	1	2	5	NA	NA	5
Knee Height. Sitting	0	2	3	NA	NA	3
Lateral Femoral Epicondyle Height	1	1	3	NA	NA	1
Lateral Malleolus Height	1	1	4	NA	NA	3
Menton-Sellion Length	1	NA	NA	NA	NA	1
Menton-Top of Head	1	NA	4	NA	NA	3
Midshoulder Height	3	4	3	3	4	4
Midshoulder Height, Sitting	3	5	3	3	3	5
Midthigh Breadth	3	NA	6	NA	NA	3
Midthigh Circumference	2	NA	6	NA	NA	8
Midthigh Depth	2	NA	9	NA	NA	7
Midthigh Height	1	2	3	NA	NA	3
Neck Breadth	2	NA	4	6	NA	6
Neck Circumference	2	NA	3	11	NA	4
Neck Depth	1	NA	3	2	NA	2
Neck Height. Lateral	2	1	2	2	3	5
Popliteal Height	1	1	6	NA	NA	3
Radiale-Stylion Length	3	NA	NA	NA	NA	NA
Sellion-Back of Head	1	NA	NA	NA	NA	2
Sellion-Top of Head	2	NA	5	NA	NA	1

TABLE E-4 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Shoulder Circ., Compressed	NA	6	5	9	6	18
Shoulder Circ., Uncompressed	11	6	6	11	8	14
Sitting Height	3	3	2	NA	NA	3
Stature	4	2	3	3	3	2
Thigh Breadth. Crotch	5	NA	6	NA	NA	4
Thigh Circumference, Crotch	4	NA	5	NA	11	9
Thigh Clearance	1	NA	3	NA	NA	2
Thigh Depth, Crotch	3	NA	10	NA	7	7
Trochanteric Height	4	4	3	NA	NA	2
Vertical Trunk Circumference	8	10	13	13	17	10
Waist Breadth	4	5	4	9	3	4
Waist Circumference, Omphalion	4	10	5	16	9	7
Waist Depth	3	3	5	6	7	4
Waist Height, Omphalion	6	5	2	5	3	3
Weight	1	0	1	1	1	0
Wrist Breadth	1	NA	2	3	NA	2
Wrist Circumference	2	NA	5	3	NA	5
Wrist Depth	0	NA	5	2	NA	3

TABLE E-5

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
AVIATOR COLD WEATHER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	3	1	5	3	4	2	NA	4
Acromion Height	4	NA	3	4	5	5	3	3
Acromion-Radiale Length	2	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	1	8	3	2	NA	NA	5
Ankle Circumference	1	3	7	4	2	NA	NA	3
Ankle Depth	0	1	5	6	3	NA	NA	3
Ankle Height	1	1	1	1	1	NA	NA	3
Axilla (Scye) Height	3	NA	7	7	7	4	9	5
Ball of Foot Circumference	1	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	2	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	1	NA	1	3	NA	4	4	4
Biceps Breadth, Flexed	3	NA	4	4	NA	3	NA	5
Biceps Circumference, Flexed	2	NA	5	6	NA	3	NA	6
Biceps Depth, Flexed	1	NA	8	4	NA	4	NA	4
Bideltoid Breadth, Compressed	NA	NA	2	3	NA	2	NA	3
Bideltoid Breadth, Uncompressed	3	NA	4	2	NA	6	NA	6
Bimalleolar Breadth	1	1	5	3	2	NA	NA	4
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	NA	4	4	4	6	NA	7	3
Buttock Circumference, Uncompressed	1	2	5	4	4	NA	3	4
Buttock Depth, Compressed	NA	5	4	3	1	NA	6	3
Buttock Depth, Uncompressed	6	3	4	3	3	NA	6	5
Buttock Height	1	3	2	3	1	NA	2	4
Buttock-Knee Length	3	3	4	4	5	5	5	4

TABLE E-5 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Buttock-Popliteal Length	4	5	6	2	7	4	4	7
Calf Breadth	2	1	6	5	5	NA	NA	3
Calf Circumference	1	1	5	7	4	NA	NA	5
Calf Depth	0	0	7	5	4	NA	NA	5
Calf Height	1	3	3	1	1	NA	NA	2
Chest Breadth	2	NA	11	5	NA	6	4	6
Chest Circumference	6	NA	6	2	6	10	4	4
Chest Depth	1	NA	6	4	4	3	5	4
Chest Depth - Deltoid Point, Comp.	NA	NA	5	5	6	5	7	4
Chest Depth - Deltoid Point, Uncomp.	2	NA	2	3	3	5	4	1
Chest Height	4	NA	5	3	2	2	3	2
Crotch Height	4	1	2	5	6	NA	5	4
Deltoid Point Height	3	NA	2	4	2	2	3	5
Ectoorbitale-Top of Head	2	NA	NA	NA	NA	NA	NA	NA
Elbow Breadth	3	NA	6	2	NA	3	NA	3
Elbow Circumference	2	NA	5	5	NA	5	NA	5
Elbow Depth	1	NA	7	4	NA	3	NA	1
Eye Height, Sitting	3	3	3	5	5	NA	NA	2
Foot Breadth Horizontal	1	NA	NA	NA	NA	NA	NA	NA
Foot Length	1	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	1	NA	6	4	NA	5	NA	4
Forearm Circumference, Flexed	3	NA	6	3	NA	5	NA	3
Forearm Depth, Flexed	2	NA	4	1	NA	5	NA	4
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	1	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	1	NA	NA	NA	NA	NA	NA	NA
Hand Length	1	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	1	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA	NA	NA

TABLE E-5 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Head (Helmet)Circumference	2	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	1	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	NA	4	1	4	3	NA	NA	2
Hip Breadth, Uncompressed	2	2	1	2	2	NA	NA	3
Knee Breadth	1	2	3	5	5	NA	NA	4
Knee Circumference	2	3	5	4	5	NA	NA	4
Knee Depth	1	3	6	5	5	NA	NA	3
Knee Height, Midpatella	2	2	4	3	2	NA	NA	2
Knee Height, Sitting	1	2	3	1	2	NA	NA	2
Lateral Femoral Epicondyle Height	1	3	3	3	1	NA	NA	1
Lateral Malleolus Height	1	1	1	1	1	NA	NA	I
Menton-Sellion Length	2	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	1	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	2	NA	4	3	2	5	3	2
Midshoulder Height, Sitting	2	2	3	3	3	3	3	3
Midthigh Breadth	1	NA	3	5	2	NA	NA	5
Midthigh Circumference	4	4	5	6	1	NA	NA	2
Midthigh Depth	3	3	4	4	9	NA	NA	2
Midthigh Height	1	NA	4	1	2	NA	NA	3
Neck Breadth	2	NA	NA	5	NA	3	3	1
Neck Circumference	2	NA	NA	4	NA	5	5	3
Neck Depth	1	NA	NA	5	NA	4	4	1
Neck Height, Lateral	2	NA	3	3	2	2	4	2
Popliteal Height	0	3	3	3	3	NA	NA	3
Radiale-Stylion Length	2	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	1	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	2	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Compressed	NA	NA	5	3	7	3	4	2
Shoulder Circumference, Uncompressed	4	NA	5	6	2	9	6	2

TABLE E-5 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Sitting Height	2	3	2	3	3	NA	NA	4
Stature	2	NA	2	4	3	4	3	2
Thigh Breadth, Crotch	3	2	5	2	2	NA	3	5
Thigh Circumference, Crotch	3	3	6	3	5	NA	5	2
Thigh Clearance	2	2	2	2	2	NA	NA	0
Thigh Depth, Crotch	3	2	4	4	7	NA	3	2
Trochanteric Height	2	3	3	3	2	NA	NA	4
Vertical Trunk Circumference	6	6	7	6	7	6	9	4
Waist Breadth	2	4	3	2	2	5	3	4
Waist Circumference, Omphalion	2	11	5	2	3	3	5	2
Waist Depth	3	6	5	3	1	3	4	2
Waist Height, Omphalion	3	1	3	5	3	2	4	3
Weight	0	0	0	0	0	0	0	0
Wrist Breadth	1	NA	6	2	NA	3	NA	2
Wrist Circumference	1	NA	3	3	NA	2	NA	3
Wrist Depth	1	NA	4	4	NA	1	NA	2

TABLE E-6

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
AVIATOR COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	3	4	6	3	5	4	NA	6
Acromion Height	3	NA	4	4	4	1	4	6
Acromion-Radiale Length	2	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	2	8	3	4	NA	NA	2
Ankle Circumference	1	2	3	5	10	NA	NA	2
Ankle Depth	0	2	9	6	5	NA	NA	7
Ankle Height	1	1	1	2	1	NA	NA	4
Axilla (Scye) Height	4	NA	9	7	7	7	4	7
Ball of Foot Circumference	1	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	2	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	3	NA	4	2	NA	2	2	5
Biceps Breadth, Flexed	2	NA	4	5	NA	3	NA	4
Biceps Circumference, Flexed	2	NA	6	6	NA	7	NA	6
Biceps Depth, Flexed	1	NA	8	4	NA	4	NA	2
Bideltoid Breadth, Compressed	NA	NA	7	3	NA	4	NA	2
Bideltoid Breadth, Uncompressed	3	NA	5	3	NA	4	NA	5
Bimalleolar Breadth	1	2	12	5	4	NA	NA	4
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	NA	5	5	5	5	NA	11	5
Buttock Circumference, Uncompressed	3	7	3	5	5	NA	9	7
Buttock Depth, Compressed	NA	7	5	5	4	NA	6	2
Buttock Depth, Uncompressed	4	8	10	4	6	NA	8	2
Buttock Height	1	2	5	5	4	NA	4	6
Buttock-Knee Length	2	4	6	4	8	5	6	4

TABLE E-6 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Buttock-Popliteal Length	3	5	7	7	11	5	6	8
Calf Breadth	1	1	6	6	5	NA	NA	3
Calf Circumference	1	1	7	4	5	NA	NA	5
Calf Depth	1	1	8	5	5	NA	NA	2
Calf Height	0	3	2	2	4	NA	NA	4
Chest Breadth	2	NA	10	7	NA	7	3	6
Chest Circumference	9	NA	9	7	8	12	4	6
Chest Depth	2	NA	7	2	4	8	8	5
Chest Depth - Deltoid Point, Comp	NA	NA	5	6	6	8	7	4
Chest Depth - Deltoid Point, Uncomp	2	NA	3	5	2	4	5	3
Chest Height	6	NA	5	3	3	6	3	4
Crotch Height	4	8	8	5	4	NA	4	8
Deltoid Point Height	4	NA	2	6	4	3	2	4
Ectoorbitale-Top of Head	1	NA	NA	NA	NA	NA	NA	NA
Elbow Breadth	1	NA	8	5	NA	4	NA	5
Elbow Circumference	1	NA	7	6	NA	6	NA	4
Elbow Depth	1	NA	8	5	NA	2	NA	5
Eye Height, Sitting	5	4	3	5	4	NA	NA	5
Foot Breadth Horizontal	1	NA	NA	NA	NA	NA	NA	NA
Foot Length	1	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	2	NA	6	3	NA	3	NA	5
Forearm Circumference, Flexed	3	NA	10	10	NA	7	NA	7
Forearm Depth, Flexed	2	NA	7	4	NA	2	NA	3
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	0	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	3	NA	NA	NA	NA	NA	NA	NA
Hand Length	2	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	0	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA	NA	NA

TABLE E-6 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Head (Helmet) Circumference	1	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	1	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	NA	4	2	2	3	NA	NA	3
Hip Breadth, Uncompressed	3	4	4	3	4	NA	NA	3
Knee Breadth	1	1	5	7	4	NA	NA	4
Knee Circumference	3	8	11	9	5	NA	NA	3
Knee Depth	0	3	10	11	5	NA	NA	8
Knee Height, Midpatella	1	4	3	6	3	NA	NA	4
Knee Height, Sitting	0	2	2	1	3	NA	NA	2
Lateral Femoral Epicondyle Height	1	2	3	2	3	NA	NA	2
Lateral Malleolus Height	1	1	2	1	2	NA	NA	2
Menton-Sellion Length	1	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	1	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	3	NA	2	4	5	5	4	3
Midshoulder Height, Sitting	3	4	3	3	3	3	5	5
Midthigh Breadth	3	2	8	7	5	NA	NA	7
Midthigh Circumference	2	11	5	4	10	NA	NA	6
Midthigh Depth	2	4	3	4	7	NA	NA	10
Midthigh Height	1	4	4	3	3	NA	NA	7
Neck Breadth	2	NA	NA	5	NA	3	3	7
Neck Circumference	2	NA	NA	3	NA	3	3	4
Neck Depth	1	NA	NA	3	NA	4	5	3
Neck Height, Lateral	2	NA	3	4	3	2	5	3
Popliteal Height	1	4	10	3	10	NA	NA	1
Radiale-Stylion Length	3	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	1	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	2	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Compressed	NA	NA	5	8	10	5	9	4
Shoulder Circumference, Uncompressed	11	NA	5	6	9	8	6	5

TABLE E-6 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Sitting Height	3	3	4	4	2	NA	NA	6
Stature	4	NA	6	2	3	5	3	8
Thigh Breadth, Crotch	5	5	9	3	6	NA	5	9
Thigh Circumference, Crotch	4	8	5	3	10	NA	12	7
Thigh Clearance	1	2	4	2	3	NA	NA	4
Thigh Depth, Crotch	3	5	7	8	6	NA	11	8
Trochanteric Height	4	3	4	5	4	NA	NA	5
Vertical Trunk Circumference	8	13	14	13	8	15	11	7
Waist Breadth	4	5	5	3	3	4	4	5
Waist Circumference, Omphalion	4	10	12	5	9	6	6	3
Waist Depth	3	3	6	3	6	5	4	5
Waist Height, Omphalion	6	6	3	3	5	4	2	5
Weight	1	0	0	0	0	0	0	0
Wrist Breadth	1	NA	6	5	NA	3	NA	3
Wrist Circumference	2	NA	3	1	NA	4	NA	2
Wrist Depth	0	NA	5	6	NA	1	NA	2

TABLE E-7

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Acromial Height, Sitting	3	3	NA	NA	6	6	11
Acromion Height	3	3	NA	4	5	7	3
Acromion-Radiale Length	2	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	0	NA	NA	2	NA	1
Ankle Circumference	1	3	NA	NA	4	NA	4
Ankle Depth	0	0	NA	NA	2	NA	2
Ankle Height	1	1	NA	NA	2	NA	1
Axilla (Scye) Height	4	5	NA	NA	4	NA	4
Ball of Foot Circumference	1	1	NA	NA	NA	NA	NA
Ball of Foot Length	2	2	NA	NA	NA	NA	NA
Biacromial Breadth	3	4	NA	NA	4	3	3
Biceps Breadth, Flexed	2	2	NA	NA	6	NA	5
Biceps Circumference, Flexed	2	4	NA	NA	6	NA	5
Biceps Depth, Flexed	1	3	NA	NA	7	NA	4
Bideltoid Breadth, Compressed	NA	4	NA	NA	5	NA	1
Bideltoid Breadth, Uncompressed	3	7	NA	NA	5	NA	2
Bimalleolar Breadth	1	0	NA	NA	1	NA	2
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	2	NA	1
Buttock Circumference, Compressed	NA	5	NA	NA	10	NA	8
Buttock Circumference, Uncompressed	3	4	NA	NA	5	NA	10
Buttock Depth, Compressed	NA	1	NA	NA	5	NA	4
Buttock Depth, Uncompressed	4	4	NA	NA	5	NA	6
Buttock Height	1	3	NA	NA	5	NA	5

TABLE E-7 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Buttock-Knee Length	2	4	NA	5	5	3	3
Buttock-Popliteal Length	3	3	NA	5	9	11	3
Calf Breadth	1	1	NA	NA	4	NA	2
Calf Circumference	1	1	NA	NA	10	NA	5
Calf Depth	1	1	NA	NA	5	NA	3
Calf Height	0	2	NA	NA	6	NA	2
Chest Breadth	2	5	NA	8	7	5	9
Chest Circumference	9	8	4	4	7	7	7
Chest Depth	2	6	5	2	4	4	4
Chest Depth - Deltoid Point, Comp	NA	4	6	4	3	4	3
Chest Depth - Deltoid Point, Uncomp	2	4	4	4	4	3	4
Chest Height	6	3	6	3	5	6	4
Crotch Height	4	4	NA	NA	8	NA	14
Deltoid Point Height	4	5	4	3	5	5	3
Ectoorbitale-Top of Head	1	NA	NA	NA	3	NA	6
Elbow Breadth	1	NA	NA	NA	11	NA	4
Elbow Circumference	1	NA	NA	NA	2	NA	4
Elbow Depth	1	NA	NA	NA	11	NA	7
Eye Height, Sitting	5	5	NA	NA	7	NA	3
Foot Breadth Horizontal	1	1	NA	NA	NA	NA	NA
Foot Length	1	1	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	2	NA	NA	NA	3	NA	5
Forearm Circumference, Flexed	3	NA	NA	NA	8	NA	9
Forearm Depth, Flexed	2	NA	NA	NA	6	NA	2
Glabella-Helmet Rim	NA	NA	NA	NA	3	NA	2
Hand Breadth	0	NA	NA	NA	1	NA	NA
Hand Circumference	3	NA	NA	NA	1	NA	NA
Hand Length	2	NA	NA	NA	5	NA	NA
Hand Thickness	0	NA	NA	NA	3	NA	NA

TABLE E-7 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA	NA
Head (Helmet) Circumference	1	NA	NA	NA	NA	NA	NA
Heel Breadth	1	1	NA	NA	1	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	3	NA	3
Hip Breadth, Compressed	NA	2	NA	NA	2	NA	3
Hip Breadth, Uncompressed	3	3	NA	NA	3	NA	4
Knee Breadth	1	NA	NA	NA	7	NA	7
Knee Circumference	3	NA	NA	NA	7	NA	11
Knee Depth	0	NA	NA	NA	5	NA	4
Knee Height, Midpatella	1	2	NA	NA	3	NA	3
Knee Height, Sitting	0	2	NA	NA	2	NA	4
Lateral Femoral Epicondyle Height	1	1	NA	NA	3	NA	2
Lateral Malleolus Height	1	1	NA	NA	1	NA	2
Menton-Sellion Length	1	NA	NA	NA	1	NA	NA
Menton-Top of Head	1	NA	NA	NA	5	NA	2
Midshoulder Height	3	4	NA	4	7	5	3
Mldshoulder Height, Sitting	3	5	NA	2	2	3	2
Midthigh Breadth	3	NA	NA	NA	1	NA	4
Midthigh Circumference	2	NA	NA	NA	5	NA	8
Midthigh Depth	2	NA	NA	NA	4	NA	4
Midthigh Height	1	2	NA	NA	5	NA	4
Neck Breadth	2	NA	4	NA	2	NA	5
Neck Circumference	2	NA	6	NA	4	NA	5
Neck Depth	1	NA	1	NA	4	NA	6
Neck Height, Lateral	2	1	NA	2	2	4	5
Popliteal Height	1	1	NA	NA	3	NA	6
Radiale-Stylion Length	3	NA	NA	NA	NA	,NA	NA
Sellion-Back of Head	1	NA	NA	NA	4	:NA	4

TABLE E-7 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Sellion-Top of Head	2	NA	NA	NA	5	NA	4
Shoulder Circumference, Compressed	NA	6	6	8	9	4	4
Shoulder Circumference, Uncompressed	11	6	4	4	7	5	3
Sitting Height	3	3	NA	NA	6	NA	2
Stature	4	2	4	2	5	2	3
Thigh Breadth, Crotch	5	NA	NA	NA	2	NA	3
Thigh Circumference, Crotch	4	NA	NA	NA	4	NA	6
Thigh Clearance	1	NA	NA	NA	3	NA	3
Thigh Depth, Crotch	3	NA	NA	NA	5	NA	3
Trochanteric Height	4	4	NA	NA	5	NA	4
Vertical Trunk Circumference	8	10	16	6	18	9	8
Waist Breadth	4	5	5	2	3	5	3
Waist Circumference, Omphalion	4	10	7	8	3	9	3
Waist Depth	3	3	5	6	3	5	8
Waist Height, Omphalion	6	5	6	4	4	2	5
Weight	1	0	0	0	0	0	1
Wrist Breadth	1	NA	NA	NA	2	NA	1
Wrist Circumference	2	NA	NA	NA	9	NA	3
Wrist Depth	0	NA	NA	NA	3	NA	2

TABLE E-8

MEAN ABSOLUTE DELTAS BETWEEN INITIAL
AND REPEATED MEASUREMENTS BY CLOTHING LAYER
COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Acromial Height. Sitting	3	4	8	NA	5	4	3	NA	6
Acromion Height	3	NA	4	5	5	5	2	1	5
Acromion-Radiale Length	2	NA	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	2	8	NA	3	5	NA	NA	5
Ankle Circumference	1	2	3	NA	6	8	NA	NA	2
Ankle Depth	0	2	9	NA	3	5	NA	NA	5
Ankle Height	1	1	1	NA	3	2	NA	NA	2
Axilla (Scye) Height	4	NA	9	NA	7	NA	4	4	5
Ball of Foot Circumference	1	NA	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	2	NA	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	3	NA	4	NA	3	NA	1	1	4
BICEPS Breadth, Flexed	2	NA	4	NA	3	NA	1	NA	3
Biceps Circumference, Flexed	2	NA	6	NA	5	NA	7	NA	5
Biceps Depth, Flexed	1	NA	8	NA	8	NA	6	NA	3
Bideltoid Breadth, Compressed	NA	NA	7	NA	2	NA	4	4	3
Bideltoid Breadth, Uncompressed	3	NA	5	NA	7	NA	2	2	3
Bimalleolar Breadth	1	2	12	NA	8	4	NA	NA	2
Bitragion (Ear Cup) Breadth	1	NA	NA	NA	NA	2	1	NA	NA
Buttock Circumference, Compressed	NA	5	5	NA	8	6	NA	NA	3
Buttock Circumference, Uncomp.	3	7	3	NA	9	6	NA	NA	8
Buttock Depth, Compressed	NA	7	5	NA	4	3	NA	NA	2
Buttock Depth, Uncompressed	4	8	10	NA	3	4	NA	NA	3
Buttock Height	1	2	5	NA	4	6	NA	NA	4
Buttock-Knee Length	2	4	6	NA	5	4	NA	NA	6

TABLE E-8 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Buttock-Popliteal Length	3	5	7	NA	5	7	NA	NA	10
Calf Breadth	1	1	6	NA	5	4	NA	NA	3
Calf Circumference	1	1	7	NA	6	3	NA	NA	5
Calf Depth	1	1	8	NA	4	3	NA	NA	2
Calf Height	0	3	2	NA	2	1	NA	NA	1
Chest Breadth	2	NA	10	5	3	3	9	7	6
Chest Circumference	9	NA	9	10	10	9	9	9	8
Chest Depth	2	NA	7	3	4	4	5	9	5
Chest Depth - Deltoid Point, Comp.	NA	NA	5	4	5	4	3	3	5
Chest Depth - Deltoid Point, Uncomp.	2	NA	3	2	5	4	4	3	2
Chest Height	6	NA	5	5	3	5	5	6	6
Crotch Height	4	8	8	NA	6	6	NA	NA	10
Deltoid Point Height	4	NA	2	6	5	4	4	3	3
Ectoorbitale-Top of Head	1	NA	NA	NA	NA	NA	2	NA	NA
Elbow Breadth	1	NA	8	NA	4	NA	3	NA	4
Elbow Circumference	1	NA	7	NA	9	NA	7	NA	5
Elbow Depth	1	NA	8	NA	5	NA	4	NA	3
Eye Height, Sitting	5	4	3	NA	4	4	NA	NA	5
Foot Breadth Horizontal	1	NA	NA	NA	NA	NA	NA	NA	NA
Foot Length	1	NA	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	2	NA	6	NA	3	NA	5	NA	4
Forearm Circumference, Flexed	3	NA	10	NA	6	NA	4	NA	4
Forearm Depth, Flexed	2	NA	7	NA	3	NA	1	NA	5
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	1	NA	NA
Hand Breadth	0	NA	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	3	NA	NA	NA	NA	NA	NA	NA	NA
Hand Length	2	NA	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	0	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	1	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	1	NA	NA	NA	NA	NA	NA	NA	NA

TABLE E-8 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Head (Helmet) Circumference	1	NA	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	1	NA	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	3	NA	NA
Hip Breadth, Compressed	NA	4	2	NA	3	4	NA	NA	3
Hip Breadth, Uncompressed	3	4	4	NA	3	3	NA	NA	2
Knee Breadth	1	1	5	NA	7	4	NA	NA	4
Knee Circumference	3	8	11	NA	6	6	NA	NA	4
Knee Depth	0	3	10	NA	4	4	NA	NA	2
Knee Height, Midpatella	1	4	3	NA	5	4	NA	NA	4
Knee Height, Sitting	0	2	2	NA	3	5	NA	NA	3
Lateral Femoral Epicondyle Height	1	2	3	NA	2	2	NA	NA	2
Lateral Malleolus Height	1	1	2	NA	0	1	NA	NA	1
Menton-Sellion Length	1	NA	NA	NA	NA	NA	3	NA	NA
Menton-Top of Head	1	NA	NA	NA	NA	NA	3	NA	NA
Midshoulder Height	3	NA	2	3	4	3	5	5	4
Midshoulder Height, Sitting	3	4	3	3	4	4	3	4	5
Midthlgh Breadth	3	2	8	NA	4	3	NA	NA	4
Midthigh Circumference	2	11	5	NA	5	10	NA	NA	4
Midthigh Depth	2	4	3	NA	5	7	NA	NA	5
Midthigh Height	1	4	4	NA	4	4	NA	NA	6
Neck Breadth	2	NA	NA	NA	2	NA	3	NA	5
Neck Circumference	2	NA	NA	NA	4	NA	4	NA	7
Neck Depth	1	NA	NA	NA	3	NA	5	NA	3
Neck Height, Lateral	2	NA	3	4	2	3	3	5	5
Popliteal Height	1	4	10	NA	6	7	NA	NA	3
Radiale-Stylion Length	3	NA	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	1	NA	NA	NA	NA	NA	2	NA	NA
Sellion-Top of Head	2	NA	NA	NA	NA	NA	2	NA	NA
Shoulder Circumference, Compressed	NA	NA	5	4	6	5	5	3	5
Shoulder Circumference, Uncompressed	11	NA	5	4	7	5	9	9	7

TABLE E-8 (continued)

	NUDE	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Sitting Height	3	3	4	NA	2	4	4	NA	4
Stature	4	NA	6	3	3	3	3	3	5
Thigh Breadth, Crotch	5	5	9	NA	4	4	NA	NA	4
Thigh Circumference, Crotch	4	8	5	NA	7	7	NA	NA	3
Thigh Clearance	1	2	4	NA	2	5	NA	5	3
Thigh Depth, Crotch	3	5	7	NA	5	6	NA	NA	6
Trochanteric Height	4	3	4	NA	4	5	NA	NA	2
Vertical Trunk Circumference	8	13	14	16	10	10	8	7	6
Waist Breadth	4	5	5	2	3	4	3	7	2
Waist Circumference, Omphalion	4	10	12	5	5	5	3	8	5
Waist Depth	3	3	6	3	5	4	7	5	4
Waist Height, Omphalion	6	6	3	4	5	4	4	3	4
Weight	1	0	0	1	0	0	0	0	0
Wrist Breadth	1	NA	6	NA	3	NA	2	NA	1
Wrist Circumference	2	NA	3	NA	5	NA	3	NA	2
Wrist Depth	0	NA	5	NA	1	NA	2	NA	3

APPENDIX F

DIFFERENCES BETWEEN DRESS AND REDRESS MEASUREMENTS

TABLE F-1

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
GROUND SOLDIER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	8	4	8	3
Acromion Height	7	11	10	0
Acromion-Radiale Length	NA	NA	NA	NA
Ankle Breadth	1	4	12	NA
Ankle Circumference	3	7	5	NA
Ankle Depth	3	4	3	NA
Ankle Height	3	1	9	NA
Axilla (Scye) Height	2	10	6	6
Ball of Foot Circumference	0	0	2	NA
Ball of Foot Length	5	0	3	NA
Biacromial Breadth	4	14	17	9
Biceps Breadth, Flexed	4	10	15	NA
Biceps Circumference, Flexed	2	4	14	NA
Biceps Depth, Flexed	4	2	18	NA
Bideltoid Breadth, Compressed	4	4	9	4
Bideltoid Breadth, Uncompressed	3	3	4	10
Bimalleolar Breadth	1	1	5	NA
Bitragion (Ear Cup) Breadth	NA	0	NA	NA
Buttock Circumference, Compressed	7	11	10	NA
Buttock Circumference, Uncompressed	5	5	8	NA
Buttock Depth, Compressed	10	9	5	NA
Buttock Depth, Uncompressed	4	3	4	NA
Buttock Height	2	1	1	NA
Buttock-Knee Length	1	3	11	4
Buttock-Popliteal Length	9	12	6	3
Calf Breadth	1	16	7	NA
Calf Circumference	1	7	1	NA
Calf Depth	0	14	9	NA
Calf Height	4	3	2	NA
Chest Breadth	5	20	13	14
Chest Circumference	4	13	0	4
Chest Depth	4	4	16	11
Chest Depth - Deltoid Point, Comp	5	5	7	4
Chest Depth - Deltoid Point, Uncomp	2	15	5	12
Chest Height	2	8	3	3
Crotch Height	11	5	3	NA
Deltoid Point Height	12	6	9	7
Ectoorbitale-Top of Head	NA	2	5	NA

TABLE F-1 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Elbow Breadth	NA	8	16	NA
Elbow Circumference	NA	8	8	NA
Elbow Depth	NA	16	11	NA
Eye Height, Sitting	0	6	4	NA
Foot Breadth Horizontal	4	0	1	NA
Foot Length	1	0	2	NA
Forearm Breadth, Flexed	NA	9	7	NA
Forearm Circumference, Flexed	NA	3	1	1
Forearm Depth, Flexed	NA	8	13	NA
Glabella-Helmet Rim	NA	0	1	NA
Hand Breadth	NA	NA	3	NA
Hand Circumference	NA	NA	2	NA
Hand Length	NA	NA	14	NA
Hand Thickness	NA	NA	4	NA
Head (Helmet) Breadth	NA	0	NA	NA
Head (Helmet) Length	NA	0	NA	NA
Head (Helmet)Circumference	NA	0	NA	NA
Heel Breadth	1	0	0	NA
Helmet Rim-Top of Head	NA	1	4	NA
Hip Breadth, Compressed	2	4	6	NA
Hip Breadth, Uncompressed	3	9	6	NA
Knee Breadth	NA	6	20	NA
Knee Circumference	NA	21	22	NA
Knee Depth	NA	10	17	NA
Knee Height, Midpatella	2	2	2	NA
Knee Height, Sitting	2	3	6	NA
Lateral Femoral Epicondyle Height	1	5	1	NA
Lateral Malleolus Height	2	1	2	NA
Menton-Sellion Length	NA	2	1	NA
Menton-Top of Head	NA	3	7	NA
Midshoulder Height	2	3	12	11
Midshoulder Height, Sitting	2	4	6	9
Midthigh Breadth	NA	7	9	NA
Midthigh Circumference	NA	5	17	NA
Midthigh Depth	NA	12	16	NA
Midthigh Height	1	2	2	NA
Neck Breadth	NA	6	11	14
Neck Circumference	NA	1	28	38
Neck Depth	NA	1	1	22
Neck Height, Lateral	3	5	10	7
Popliteal Height	4	7	5	NA
Radiale-Stylion Length	NA	NA	NA	NA
Sellion-Back of Head	NA	1	1	NA
Sellion-Top of Head	NA	3	5	NA

TABLE F-1 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Shoulder Circumference, Compressed	5	10	17	5
Shoulder Circumference, Uncompressed	4	6	3	7
Sitting Height	0	3	3	NA
Stature	4	3	3	8
Thigh Breadth, Crotch	NA	6	7	NA
Thigh Circumference, Crotch	NA	3	7	NA
Thigh Clearance	NA	4	2	NA
Thigh Depth, Crotch	NA	3	11	NA
Trochanteric Height	2	1	2	NA
Vertical Trunk Circumference	2	2	6	14
Waist Breadth	7	1	7	10
Waist Circumference, Omphalion	3	21	21	14
Waist Depth	15	3	13	8
Waist Height, Omphalion	2	10	10	12
Weight	0	1	0	2
Wrist Breadth	NA	0	7	NA
Wrist Circumference	NA	3	4	NA
Wrist Depth	NA	3	3	NA

TABLE F-2

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
GROUND SOLDIER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Acromial Height, Sitting	5	2	3	6
Acromion Height	5	4	6	1
Acromion-Radiale Length	NA	NA	NA	NA
Ankle Breadth	1	4	11	NA
Ankle Circumference	3	11	3	NA
Ankle Depth	2	7	10	NA
Ankle Height	4	6	6	NA
Axilla (Scye) Height	18	9	3	15
Ball of Foot Circumference	2	2	2	NA
Ball of Foot Length	2	2	2	NA
Biacromial Breadth	11	1	6	4
Biceps Breadth, Flexed	3	6	8	NA
Biceps Circumference, Flexed	6	9	2	NA
Biceps Depth, Flexed	2	4	5	NA
Bideltoid Breadth, Compressed	1	7	11	5
Bideltoid Breadth, Uncompressed	7	7	4	1
Bimalleolar Breadth	3	1	8	NA
Bitragion (Ear Cup) Breadth	NA	0	NA	NA
Buttock Circumference, Compressed	12	7	6	NA
Buttock Circumference, Uncompressed	9	9	11	NA
Buttock Depth, Compressed	3	2	9	NA
Buttock Depth, Uncompressed	16	24	14	NA
Buttock Height	2	3	2	NA
Buttock-Knee Length	7	18	11	10
Buttock-Popliteal Length	6	11	9	11
Calf Breadth	1	6	4	NA
Calf Circumference	1	4	37	NA
Calf Depth	0	26	5	NA
Calf Height	2	3	1	NA
Chest Breadth	6	19	8	6
Chest Circumference	10	37	15	13
Chest Depth	6	4	18	5
Chest Depth - Deltoid Point, Comp	8	2	7	1
Chest Depth - Deltoid Point, Uncomp	1	4	4	6
Chest Height	4	3	6	3
Crotch Height	11	15	26	NA
Deltoid Point Height	7	3	10	3
Ectoorbitale-Top of Head	NA	8	7	NA

TABLE F-2 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Elbow Breadth	NA	10	14	NA
Elbow Circumference	NA	7	30	NA
Elbow Depth	NA	7	7	NA
Eye Height, Sitting	4	2	7	NA
Foot Breadth Horizontal	2	2	1	NA
Foot Length	3	1	2	NA
Forearm Breadth, Flexed	NA	2	5	NA
Forearm Circumference, Flexed	NA	13	12	12
Forearm Depth, Flexed	NA	5	12	NA
Glabella-Helmet Rim	NA	2	6	NA
Hand Breadth	NA	NA	5	NA
Hand Circumference	NA	NA	4	NA
Hand Length	NA	NA	11	NA
Hand Thickness	NA	NA	8	NA
Head (Helmet) Breadth	NA	0	NA	NA
Head (Helmet) Length	NA	0	NA	NA
Head (Helmet)Circumference	NA	0	NA	NA
Heel Breadth	3	0	3	NA
Helmet Rim-Top of Head	NA	10	6	NA
Hip Breadth, Compressed	4	4	10	NA
Hip Breadth, Uncompressed	8	19	15	NA
Knee Breadth	NA	8	27	NA
Knee Circumference	NA	11	18	NA
Knee Depth	NA	18	16	NA
Knee Height, Midpatella	3	2	1	NA
Knee Height, Sitting	4	3	4	NA
Lateral Femoral Epicondyle Height	2	2	2	NA
Lateral Malleolus Height	2	5	2	NA
Menton-Sellion Length	NA	2	3	NA
Menton-Top of Head	NA	9	6	NA
Midshoulder Height	3	4	11	6
Midshoulder Height, Sitting	2	6	2	6
Midthigh Breadth	NA	12	3	NA
Midthigh Circumference	NA	2	21	NA
Midthigh Depth	NA	15	7	NA
Midthigh Height	3	4	1	NA
Neck Breadth	NA	1	3	15
Neck Circumference	NA	9	5	8
Neck Depth	NA	6	4	3
Neck Height, Lateral	2	3	5	4
Popliteal Height	3	17	33	NA
Radiale-Stylion Length	NA	NA	NA	NA
Sellion-Back of Head	NA	4	4	NA
Sellion-Top of Head	NA	5	8	NA

TABLE F-2 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4
Shoulder Circumference, Compressed	9	17	13	7
Shoulder Circumference, Uncompressed	7	19	14	8
Sitting Height	1	2	3	NA
Stature	2	1	4	2
Thigh Breadth, Crotch	NA	5	2	NA
Thigh Circumference, Crotch	NA	12	17	NA
Thigh Clearance	NA	7	4	NA
Thigh Depth, Crotch	NA	5	4	NA
Trochanteric Height	4	9	4	NA
Vertical Trunk Circumference	18	20	30	19
Waist Breadth	1	12	20	7
Waist Circumference, Omphalion	13	9	18	6
Waist Depth	13	16	10	5
Waist Height, Omphalion	3	1	1	2
Weight	3	2	2	1
Wrist Breadth	NA	4	3	NA
Wrist Circumference	NA	5	14	NA
Wrist Depth	NA	4	3	NA

TABLE F-3

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
AVIATOR WARM WEATHER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	8	2	1	6	5
Acromion Height	7	6	4	8	7
Acromion-Radiale Length	NA	NA	NA	NA	NA
Ankle Breadth	1	1	NA	NA	3
Ankle Circumference	3	7	NA	NA	5
Ankle Depth	3	15	NA	NA	2
Ankle Height	3	3	NA	NA	3
Axilla (Scye) Height	2	7	13	6	11
Ball of Foot Circumference	0	NA	NA	NA	NA
Ball of Foot Length	5	NA	NA	NA	NA
Biacromial Breadth	4	6	12	22	15
Biceps Breadth, Flexed	4	8	19	NA	4
Biceps Circumference, Flexed	2	4	10	NA	14
Biceps Depth, Flexed	4	4	9	NA	4
Bideltoid Breadth, Compressed	4	3	4	NA	2
Bideltoid Breadth, Uncompressed	3	9	11	NA	2
Bimalleolar Breadth	1	3	NA	NA	1
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	7	8	NA	17	7
Buttock Circumference, Uncompressed	5	6	NA	14	3
Buttock Depth, Compressed	10	5	NA	4	5
Buttock Depth, Uncompressed	4	2	NA	6	3
Buttock Height	2	2	NA	1	2
Buttock-Knee Length	1	2	5	NA	9
Buttock-Popliteal Length	9	6	12	NA	9
Calf Breadth	1	20	NA	NA	7
Calf Circumference	1	7	NA	NA	24
Calf Depth	0	13	NA	NA	7
Calf Height	4	2	NA	NA	2
Chest Breadth	5	17	18	5	13
Chest Circumference	4	22	11	1	13
Chest Depth	4	3	10	4	9
Chest Depth - Deltoid Point, Comp	5	1	2	5	7
Chest Depth - Deltoid Point, Uncomp	2	11	9	4	2
Chest Height	2	1	3	3	7
Crotch Height	11	6	NA	6	6
Deltoid Point Height	12	5	4	11	6
Ectoorbitale-Top of Head	NA	6	NA	NA	5

TABLE F-3 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Elbow Breadth	NA	11	13	NA	1
Elbow Circumference	NA	4	10	NA	34
Elbow Depth	NA	11	10	NA	6
Eye Height, Sitting	0	4	NA	NA	8
Foot Breadth Horizontal	4	NA	NA	NA	NA
Foot Length	1	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	11	3	NA	6
Forearm Circumference, Flexed	NA	4	3	NA	22
Forearm Depth, Flexed	NA	1	13	NA	6
Glabella-Helmet Rim	NA	4	NA	NA	6
Hand Breadth	NA	3	NA	NA	NA
Hand Circumference	NA	3	NA	NA	NA
Hand Length	NA	6	NA	NA	NA
Hand Thickness	NA	3	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA
Heel Breadth	1	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	6	NA	NA	1
Hip Breadth, Compressed	2	2	NA	NA	5
Hip Breadth, Uncompressed	3	1	NA	NA	9
Knee Breadth	NA	16	NA	NA	4
Knee Circumference	NA	10	NA	NA	16
Knee Depth	NA	10	NA	NA	5
Knee Height, Midpatella	2	0	NA	NA	2
Knee Height, Sitting	2	1	NA	NA	1
Lateral Femoral Epicondyle Height	1	3	NA	NA	2
Lateral Malleolus Height	2	8	NA	NA	1
Menton-Sellion Length	NA	NA	NA	NA	4
Menton-Top of Head	NA	2	NA	NA	2
Midshoulder Height	2	5	8	4	3
Midshoulder Height, Sitting	2	5	1	2	3
Midthigh Breadth	NA	6	NA	NA	4
Midthigh Circumference	NA	4	NA	NA	8
Midthigh Depth	NA	14	NA	NA	7
Midthigh Height	1	1	NA	NA	1
Neck Breadth	NA	9	2	NA	11
Neck Circumference	NA	9	28	NA	34
Neck Depth	NA	3	6	NA	19
Neck Height, Lateral	3	2	5	3	4
Popliteal Height	4	4	NA	NA	8
Radiale-Stylion Length	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	3
Sellion-Top of Head	NA	5	NA	NA	7

TABLE F-3 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Shoulder Circumference, Compressed	5	6	7	8	4
Shoulder Circumference, Uncompressed	4	6	3	16	6
Sitting Height	0	3	NA	NA	2
Stature	4	2	2	3	4
Thigh Breadth, Crotch	NA	6	NA	NA	2
Thigh Circumference, Crotch	NA	10	NA	17	3
Thigh Clearance	NA	4	NA	NA	5
Thigh Depth, Crotch	NA	6	NA	10	12
Trochanteric Height	2	1	NA	NA	1
Vertical Trunk Circumference	2	13	1	10	6
Waist Breadth	7	9	10	21	18
Waist Circumference, Omphalion	3	13	20	16	4
Waist Depth	15	12	4	3	5
Waist Height, Omphalion	2	4	6	2	5
Weight	0	1	1	1	1
Wrist Breadth	NA	5	2	NA	5
Wrist Circumference	NA	1	2	NA	10
Wrist Depth	NA	6	2	NA	1

TABLE F-4

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
AVIATOR WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Acromial Height, Sitting	5	8	5	4	7
Acromion Height	5	8	3	6	14
Acromion-Radiale Length	NA	NA	NA	NA	NA
Ankle Breadth	1	7	NA	NA	20
Ankle Circumference	3	4	NA	NA	14
Ankle Depth	2	16	NA	NA	15
Ankle Height	4	10	NA	NA	6
Axilla (Scye) Height	18	9	7	9	1
Ball of Foot Circumference	2	NA	NA	NA	NA
Ball of Foot Length	2	NA	NA	NA	NA
Biacromial Breadth	11	21	15	16	36
Biceps Breadth, Flexed	3	6	4	NA	10
Biceps Circumference, Flexed	6	22	8	NA	17
Biceps Depth, Flexed	2	9	3	NA	7
Bideltoid Breadth, Compressed	1	9	4	NA	24
Bideltoid Breadth, Uncompressed	7	6	9	NA	18
Bimalleolar Breadth	3	4	NA	NA	6
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	12	5	NA	11	13
Buttock Circumference, Uncompressed	9	14	NA	16	13
Buttock Depth, Compressed	3	3	NA	7	13
Buttock Depth, Uncompressed	16	7	NA	4	16
Buttock Height	2	2	NA	6	3
Buttock-Knee Length	7	9	6	NA	9
Buttock-Popliteal Length	6	21	23	NA	25
Calf Breadth	1	6	NA	NA	10
Calf Circumference	1	7	NA	NA	29
Calf Depth	0	18	NA	NA	21
Calf Height	2	1	NA	NA	4
Chest Breadth	6	4	17	14	5
Chest Circumference	10	17	18	43	11
Chest Depth	6	7	16	21	15
Chest Depth - Deltoid Point, Comp	8	9	15	8	38
Chest Depth - Deltoid Point, Uncomp	1	7	5	8	37
Chest Height	4	3	1	5	6
Crotch Height	11	6	NA	15	32
Deltoid Point Height	7	9	5	12	18
Ectoorbitale-Top of Head	NA	4	NA	NA	5

TABLE F-4 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Elbow Breadth	NA	4	12	NA	11
Elbow Circumference	NA	3	18	NA	6
Elbow Depth	NA	20	20	NA	8
Eye Height, Sitting	4	5	NA	NA	4
Foot Breadth Horizontal	2	NA	NA	NA	NA
Foot Length	3	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	12	5	NA	6
Forearm Circumference, Flexed	NA	4	12	NA	12
Forearm Depth, Flexed	NA	7	4	NA	3
Glabella-Helmet Rim	NA	2	NA	NA	5
Hand Breadth	NA	2	NA	NA	NA
Hand Circumference	NA	3	NA	NA	NA
Hand Length	NA	1	NA	NA	NA
Hand Thickness	NA	0	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA
Heel Breadth	3	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	6	NA	NA	3
Hip Breadth, Compressed	4	3	NA	NA	6
Hip Breadth, Uncompressed	8	9	NA	NA	5
Knee Breadth	NA	4	NA	NA	24
Knee Circumference	NA	16	NA	NA	16
Knee Depth	NA	4	NA	NA	8
Knee Height, Midpatella	3	2	NA	NA	7
Knee Height, Sitting	4	4	NA	NA	3
Lateral Femoral Epicondyle Height	2	1	NA	NA	3
Lateral Malleolus Height	2	5	NA	NA	3
Menton-Sellion Length	NA	NA	NA	NA	2
Menton-Top of Head	NA	4	NA	NA	6
Midshoulder Height	3	1	3	7	9
Midshoulder Height, Sitting	2	2	6	6	8
Midthigh Breadth	NA	2	NA	NA	7
Midthigh Circumference	NA	3	NA	NA	15
Midthigh Depth	NA	8	NA	NA	10
Midthigh Height	3	2	NA	NA	5
Neck Breadth	NA	10	9	NA	9
Neck Circumference	NA	21	42	NA	33
Neck Depth	NA	2	4	NA	17
Neck Height, Lateral	2	3	0	5	6
Popliteal Height	3	12	NA	NA	17
Radiale-Stylion Length	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	3
Sellion-Top of Head	NA	5	NA	NA	2

TABLE F-4 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Shoulder Circumference, Compressed	9	15	12	24	104
Shoulder Circumference, Uncompressed	7	16	7	25	95
Sitting Height	1	6	NA	NA	5
Stature	2	4	3	2	8
Thigh Breadth, Crotch	NA	4	NA	NA	4
Thigh Circumference, Crotch	NA	6	NA	8	9
Thigh Clearance	NA	9	NA	NA	11
Thigh Depth, Crotch	NA	10	NA	17	8
Trochanteric Height	4	4	NA	NA	3
Vertical Trunk Circumference	18	12	12	10	24
Waist Breadth	1	12	12	3	16
Waist Circumference, Omphalion	13	5	16	28	11
Waist Depth	13	6	18	26	19
Waist Height, Omphalion	3	2	1	3	4
Weight	3	3	1	2	2
Wrist Breadth	NA	2	4	NA	5
Wrist Circumference	NA	2	3	NA	10
Wrist Depth	NA	2	2	NA	2

TABLE F-5

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
AVIATOR COLD WEATHER ENSEMBLE
FEMALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	2	8	7	3	4	NA	2
Acromion Height	NA	14	3	9	4	5	2
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	6	16	13	NA	NA	4
Ankle Circumference	3	17	30	17	NA	NA	3
Ankle Depth	4	11	16	9	NA	NA	2
Ankle Height	2	13	12	3	NA	NA	1
Axilla (Scye) Height	NA	6	6	6	11	12	2
Ball of Foot Circumference	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	NA	27	6	NA	3	6	14
Biceps Breadth, Flexed	NA	14	12	NA	11	NA	6
Biceps Circumference, Flexed	NA	7	3	NA	10	NA	4
Biceps Depth, Flexed	NA	13	7	NA	7	NA	4
Bideltoid Breadth, Compressed	NA	13	3	NA	10	NA	5
Bideltoid Breadth, Uncompressed	NA	12	6	NA	4	NA	3
Bimalleolar Breadth	3	9	8	5	NA	NA	5
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	2	3	7	4	NA	3	7
Buttock Circumference, Uncompressed	2	1	5	12	NA	10	25
Buttock Depth, Compressed	3	5	3	1	NA	6	5
Buttock Depth, Uncompressed	5	5	5	3	NA	11	2
Buttock Height	2	2	2	2	NA	4	3
Buttock-Knee Length	3	10	12	4	6	6	19

TABLE F-5 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Buttock-Popliteal Length	8	15	8	10	5	5	3
Calf Breadth	1	4	2	8	NA	NA	4
Calf Circumference	3	12	4	3	NA	NA	9
Calf Depth	2	9	7	9	NA	NA	13
Calf Height	3	3	2	6	NA	NA	2
Chest Breadth	NA	10	11	NA	16	7	6
Chest Circumference	NA	14	10	14	13	5	4
Chest Depth	NA	10	15	5	15	6	6
Chest Depth - Deltoid Point, Comp	NA	9	9	8	11	4	3
Chest Depth - Deltoid Point, Uncomp	NA	18	10	4	6	4	1
Chest Height	NA	4	10	1	6	5	3
Crotch Height	2	7	11	6	NA	13	11
Deltoid Point Height	NA	10	5	8	2	4	6
Ectoorbitale-Top of Head	NA	NA	NA	NA	NA	NA	NA
Elbow Breadth	NA	4	3	NA	5	NA	9
Elbow Circumference	NA	11	8	NA	1	NA	6
Elbow Depth	NA	6	4	NA	7	NA	8
Eye Height, Sitting	8	6	4	5	NA	NA	3
Foot Breadth Horizontal	NA	NA	NA	NA	NA	NA	NA
Foot Length	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	8	2	NA	8	NA	6
Forearm Circumference, Flexed	NA	2	9	NA	12	NA	5
Forearm Depth, Flexed	NA	4	6	NA	5	NA	7
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	NA	NA	NA	NA	NA	NA	NA
Hand Length	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA	NA

TABLE F-5 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	2	1	4	3	NA	NA	5
Hip Breadth, Uncompressed	0	4	2	2	NA	NA	5
Knee Breadth	3	2	12	5	NA	NA	10
Knee Circumference	6	12	11	6	NA	NA	8
Knee Depth	6	10	14	5	NA	NA	9
Knee Height, Midpatella	1	3	3	3	NA	NA	4
Knee Height, Sitting	2	2	1	2	NA	NA	6
Lateral Femoral Epicondyle Height	3	5	2	2	NA	NA	2
Lateral Malleolus Height	3	5	5	4	NA	NA	1
Menton-Sellion Length	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	NA	9	4	1	5	9	5
Midshoulder Height, Sitting	2	2	3	3	1	1	8
Midthigh Breadth	3	2	1	6	NA	NA	5
Midthigh Circumference	4	11	10	4	NA	NA	4
Midthigh Depth	7	6	9	5	NA	NA	7
Midthigh Height	2	4	2	2	NA	NA	4
Neck Breadth	NA	NA	5	NA	13	13	3
Neck Circumference	NA	NA	7	NA	5	5	4
Neck Depth	NA	NA	10	NA	5	5	4
Neck Height, Lateral	NA	4	3	9	5	2	4
Popliteal Height	9	5	10	6	NA	NA	4
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Compressed	NA	36	7	10	16	5	4
Shoulder Circumference, Uncompressed	NA	28	5	5	6	4	6

TABLE F-5 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Sitting Height	3	3	5	1	NA	NA	2
Stature	NA	1	4	5	5	4	1
Thigh Breadth, Crotch	5	5	5	4	NA	2	5
Thigh Circumference, Crotch	5	13	8	8	NA	15	4
Thigh Clearance	1	6	2	2	NA	NA	2
Thigh Depth, Crotch	3	5	8	14	NA	12	7
Trochanteric Height	2	1	3	2	NA	NA	2
Vertical Trunk Circumference	12	11	8	12	4	6	17
Waist Breadth	10	12	2	4	21	5	3
Waist Circumference, Omphalion	21	12	5	3	20	4	2
Waist Depth	5	8	2	6	7	4	1
Waist Height, Omphalion	5	5	9	10	3	2	7
Weight	2	1	1	1	0	1	1
Wrist Breadth	NA	17	3	NA	4	NA	2
Wrist Circumference	NA	19	1	NA	2	NA	12
Wrist Depth	NA	4	4	NA	2	NA	11

TABLE F-6

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
AVIATOR COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Acromial Height, Sitting	3	6	15	1	6	NA	9
Acromion Height	NA	5	10	6	4	4	7
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	4	15	10	13	NA	NA	4
Ankle Circumference	9	11	5	6	NA	NA	6
Ankle Depth	5	6	4	15	NA	NA	13
Ankle Height	5	10	2	7	NA	NA	5
Axilla (Scye) Height	NA	8	11	11	15	2	11
Ball of Foot Circumference	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	NA	9	20	NA	5	5	13
Biceps Breadth, Flexed	NA	13	3	NA	6	NA	7
Biceps Circumference, Flexed	NA	4	10	NA	12	NA	12
Biceps Depth, Flexed	NA	2	10	NA	7	NA	4
Bideltoid Breadth, Compressed	NA	2	5	NA	2	NA	10
Bideltoid Breadth, Uncompressed	NA	3	2	NA	6	NA	7
Bimalleolar Breadth	3	15	9	4	NA	NA	11
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	NA	NA	NA
Buttock Circumference, Compressed	1	12	9	4	NA	16	6
Buttock Circumference, Uncompressed	6	13	4	4	NA	15	24
Buttock Depth, Compressed	8	8	10	5	NA	5	6
Buttock Depth, Uncompressed	28	2	1	1	NA	2	14
Buttock Height	1	3	2	3	NA	5	1
Buttock-Knee Length	5	5	6	6	14	14	9

TABLE F-6 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Buttock-Popliteal Length	5	15	7	3	26	26	10
Calf Breadth	1	8	7	7	NA	NA	6
Calf Circumference	5	18	18	9	NA	NA	9
Calf Depth	3	9	14	4	NA	NA	8
Calf Height	5	1	2	5	NA	NA	2
Chest Breadth	NA	10	1	NA	9	4	14
Chest Circumference	NA	19	6	17	15	25	5
Chest Depth	NA	6	6	2	7	17	10
Chest Depth - Deltoid Point, Comp	NA	8	6	9	5	7	9
Chest Depth - Deltoid Point, Uncomp	NA	3	6	4	8	10	7
Chest Height	NA	8	8	5	4	12	1
Crotch Height	9	9	2	13	NA	7	21
Deltoid Point Height	NA	5	11	6	5	7	8
Ectoorbitale-Top of Head	NA	NA	NA	NA	NA	NA	NA
Elbow Breadth	NA	19	12	NA	1	NA	7
Elbow Circumference	NA	10	10	NA	13	NA	6
Elbow Depth	NA	10	13	NA	7	NA	6
Eye Height, Sitting	11	5	8	4	NA	NA	4
Foot Breadth Horizontal	NA	NA	NA	NA	NA	NA	NA
Foot Length	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	13	1	NA	2	NA	2
Forearm Circumference, Flexed	NA	7	4	NA	5	NA	4
Forearm Depth, Flexed	NA	6	6	NA	4	NA	5
Glabella-Helmet Rim	NA	NA	NA	NA	NA	NA	NA
Hand Breadth	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	NA	NA	NA	NA	NA	NA	NA
Hand Length	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA	NA

TABLE F-6 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	NA	NA	NA	NA	NA	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	NA	NA
Hip Breadth, Compressed	4	3	1	2	NA	NA	2
Hip Breadth, Uncompressed	11	7	4	7	NA	NA	20
Knee Breadth	12	4	4	8	NA	NA	15
Knee Circumference	9	12	9	21	NA	NA	18
Knee Depth	3	14	6	9	NA	NA	17
Knee Height, Midpatella	1	1	1	2	NA	NA	1
Knee Height, Sitting	2	8	3	2	NA	NA	4
Lateral Femoral Epicondyle Height	1	2	1	2	NA	NA	1
Lateral Malleolus Height	4	4	1	4	NA	NA	9
Menton-Sellion Length	NA	NA	NA	NA	NA	NA	NA
Menton-Top of Head	NA	NA	NA	NA	NA	NA	NA
Midshoulder Height	NA	4	8	6	10	6	7
Midshoulder Height, Sitting	7	3	11	6	6	10	5
Midthigh Breadth	3	7	8	8	NA	NA	13
Midthigh Circumference	9	3	2	16	NA	NA	8
Midthigh Depth	2	16	7	6	NA	NA	27
Midthigh Height	2	3	1	1	NA	NA	2
Neck Breadth	NA	NA	17	NA	6	13	2
Neck Circumference	NA	NA	15	NA	24	28	36
Neck Depth	NA	NA	1	NA	6	18	30
Neck Height, Lateral	NA	4	7	3	4	1	6
Popliteal Height	12	14	16	5	NA	NA	15
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA	NA	NA
Sellion-Top of Head	NA	NA	NA	NA	NA	NA	NA
Shoulder Circumference, Compressed	NA	10	9	7	3	10	29
Shoulder Circumference, Uncompressed	NA	11	13	6	9	13	27

TABLE F-6 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7
Sitting Height	7	5	7	2	NA	NA	7
Stature	NA	5	3	4	3	3	13
Thigh Breadth, Crotch	2	8	10	8	NA	12	14
Thigh Circumference, Crotch	2	3	23	16	NA	4	1
Thigh Clearance	4	11	3	4	NA	NA	6
Thigh Depth, Crotch	9	15	14	6	NA	11	29
Trochanteric Height	2	1	2	4	NA	NA	2
Vertical Trunk Circumference	10	1	19	11	18	7	42
Waist Breadth	1	6	5	1	6	6	10
Waist Circumference, Omphalion	13	3	14	5	7	8	17
Waist Depth	13	6	15	5	9	12	2
Waist Height, Omphalion	3	0	3	7	5	5	2
Weight	3	1	3	1	2	1	1
Wrist Breadth	NA	11	1	NA	5	NA	6
Wrist Circumference	NA	21	17	NA	7	NA	3
Wrist Depth	NA	14	7	NA	4	NA	6

TABLE F-7

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
COMBAT VEHICLE CREWMAN WARM WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Acromial Height, Sitting	5	NA	NA	20	8	15
Acromion Height	5	NA	4	10	5	11
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA
Ankle Breadth	1	NA	NA	0	NA	5
Ankle Circumference	3	NA	NA	3	NA	6
Ankle Depth	2	NA	NA	2	NA	6
Ankle Height	4	NA	NA	5	NA	5
Axilla (Scye) Height	18	NA	NA	8	NA	10
Ball of Foot Circumference	2	NA	NA	NA	NA	NA
Ball of Foot Length	2	NA	NA	NA	NA	NA
Biacromial Breadth	11	NA	NA	32	28	37
Biceps Breadth, Flexed	3	NA	NA	4	NA	7
Biceps Circumference, Flexed	6	NA	NA	4	NA	12
Biceps Depth, Flexed	2	NA	NA	4	NA	4
Bideltoid Breadth, Compressed	1	NA	NA	9	NA	6
Bideltoid Breadth, Uncompressed	7	NA	NA	7	NA	5
Bimalleolar Breadth	3	NA	NA	2	NA	11
Bitragion (Ear Cup) Breadth	NA	NA	NA	4	NA	1
Buttock Circumference, Compressed	12	NA	NA	9	NA	8
Buttock Circumference, Uncompressed	9	NA	NA	8	NA	13
Buttock Depth, Compressed	3	NA	NA	7	NA	3
Buttock Depth, Uncompressed	16	NA	NA	9	NA	4
Buttock Height	2	NA	NA	3	NA	3
Buttock-Knee Length	7	NA	5	12	21	18
Buttock-Popliteal Length	6	NA	5	7	19	9
Calf Breadth	1	NA	NA	16	NA	9
Calf Circumference	1	NA	NA	8	NA	6
Calf Depth	0	NA	NA	6	NA	15
Calf Height	2	NA	NA	1	NA	2
Chest Breadth	6	NA	4	11	2	3
Chest Circumference	10	9	13	11	26	14
Chest Depth	6	8	2	5	8	6
Chest Depth - Deltoid Point, Comp	8	5	6	10	4	10
Chest Depth - Deltoid Point, Uncomp	1	4	4	13	1	15
Chest Height	4	4	5	8	5	4
Crotch Height	11	NA	NA	4	NA	21
Deltoid Point Height	7	4	5	15	8	13
Ectoorbitale-Top of Head	NA	NA	NA	3	NA	4
Elbow Breadth	NA	NA	NA	9	NA	5
Elbow Circumference	NA	NA	NA	2	NA	12
Elbow Depth	NA	NA	NA	11	NA	20
Eye Height, Sitting	4	NA	NA	5	NA	6
Foot Breadth Horizontal	2	NA	NA	NA	NA	NA
Foot Length	3	NA	NA	NA	NA	NA

TABLE F-7 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Forearm Breadth, Flexed	NA	NA	NA	10	NA	2
Forearm Circumference, Flexed	NA	NA	NA	5	NA	12
Forearm Depth, Flexed	NA	NA	NA	14	NA	6
Glabella-Helmet Rim	NA	NA	NA	3	NA	3
Hand Breadth	NA	NA	NA	1	NA	NA
Hand Circumference	NA	NA	NA	3	NA	NA
Hand Length	NA	NA	NA	5	NA	NA
Hand Thickness	NA	NA	NA	2	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA
Heel Breadth	3	NA	NA	4	NA	NA
Helmet Rim-Top of Head	NA	NA	NA	6	NA	9
Hip Breadth, Compressed	4	NA	NA	4	NA	6
Hip Breadth, Uncompressed	8	NA	NA	2	NA	11
Knee Breadth	NA	NA	NA	7	NA	11
Knee Circumference	NA	NA	NA	14	NA	17
Knee Depth	NA	NA	NA	12	NA	13
Knee Height, Midpatella	3	NA	NA	1	NA	2
Knee Height, Sitting	4	NA	NA	3	NA	5
Lateral Femoral Epicondyle Height	2	NA	NA	1	NA	0
Lateral Malleolus Height	2	NA	NA	6	NA	3
Menton-Sellion Length	NA	NA	NA	0	NA	NA
Menton-Top of Head	NA	NA	NA	3	NA	9
Midshoulder Height	3	NA	2	10	4	9
Midshoulder Height, Sitting	2	NA	2	14	6	9
Midthigh Breadth	NA	NA	NA	3	NA	5
Midthigh Circumference	NA	NA	NA	7	NA	28
Midthigh Depth	NA	NA	NA	19	NA	14
Midthigh Height	3	NA	NA	1	NA	1
Neck Breadth	NA	8	NA	3	NA	10
Neck Circumference	NA	12	NA	25	NA	28
Neck Depth	NA	0	NA	1	NA	2
Neck Height, Lateral	2	NA	3	7	7	3
Popliteal Height	3	NA	NA	11	NA	14
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	5	NA	4
Sellion-Top of Head	NA	NA	NA	3	NA	5
Shoulder Circumference, Compressed	9	7	12	30	20	15
Shoulder Circumference, Uncompressed	7	3	12	33	17	15
Sitting Height	1	NA	NA	8	NA	2
Stature	2	2	2	4	4	6
Thigh Breadth, Crotch	NA	NA	NA	3	NA	7
Thigh Circumference, Crotch	NA	NA	NA	8	NA	13
Thigh Clearance	NA	NA	NA	3	NA	2
Thigh Depth, Crotch	NA	NA	NA	13	NA	14
Trochanteric Height	4	NA	NA	3	NA	1
Vertical Trunk Circumference	18	21	16	15	22	23
Waist Breadth	1	1	5	4	2	4
Waist Circumference, Omphalion	13	12	17	12	13	3

TABLE F-7 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
Waist Depth	13	14	8	3	8	9
Waist Height, Omphalion	3	1	1	3	2	2
Weight	3	1	1	0	6	7
Wrist Breadth	NA	NA	NA	3	NA	4
Wrist Circumference	NA	NA	NA	4	NA	9
Wrist Depth	NA	NA	NA	1	NA	3

TABLE F-8

MADs BETWEEN DRESS AND REDRESS MEASUREMENTS BY CLOTHING LAYER
COMBAT VEHICLE CREWMAN COLD WEATHER ENSEMBLE
MALES
(weight in hg, all others in mm)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Acromial Height, Sitting	3	6	NA	8	8	9	NA	10
Acromion Height	NA	5	3	10	11	15	14	4
Acromion-Radiale Length	NA	NA	NA	NA	NA	NA	NA	NA
Ankle Breadth	4	15	NA	25	6	NA	NA	6
Ankle Circumference	9	11	NA	15	14	NA	NA	7
Ankle Depth	5	6	NA	19	1	NA	NA	8
Ankle Height	5	10	NA	5	11	NA	NA	6
Axilla (Scye) Height	NA	8	NA	7	NA	4	4	2
Ball of Foot Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Ball of Foot Length	NA	NA	NA	NA	NA	NA	NA	NA
Biacromial Breadth	NA	9	NA	14	NA	6	6	17
Biceps Breadth, Flexed	NA	13	NA	7	NA	2	NA	5
Biceps Circumference, Flexed	NA	4	NA	9	NA	0	NA	6
Biceps Depth, Flexed	NA	2	NA	5	NA	4	NA	5
Bideltoid Breadth, Compressed	NA	2	NA	6	NA	7	7	11
Bideltoid Breadth, Uncompressed	NA	3	NA	12	NA	5	5	7
Bimalleolar Breadth	3	15	NA	4	6	NA	NA	6
Bitragion (Ear Cup) Breadth	NA	NA	NA	NA	4	2	NA	NA
Buttock Circumference, Compressed	1	12	NA	3	24	NA	NA	22
Buttock Circumference, Uncompressed	6	13	NA	3	19	NA	NA	24
Buttock Depth, Compressed	8	8	NA	4	10	NA	NA	6
Buttock Depth, Uncompressed	28	2	NA	3	6	NA	NA	12
Buttock Height	1	3	NA	3	1	NA	NA	3
Buttock-Knee Length	5	5	NA	5	8	NA	NA	7
Buttock-Popliteal Length	5	15	NA	13	15	NA	NA	9

TABLE F-8 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Calf Breadth	1	8	NA	7	8	NA	NA	14
Calf Circumference	5	18	NA	13	7	NA	NA	16
Calf Depth	3	9	NA	8	4	NA	NA	6
Calf Height	5	1	NA	4	4	NA	NA	2
Chest Breadth	NA	10	13	9	9	4	6	9
Chest Circumference	NA	19	6	7	12	14	7	13
Chest Depth	NA	6	2	5	3	10	10	10
Chest Depth - Deltoid Point, Comp	NA	8	7	5	9	9	10	7
Chest Depth - Deltoid Point, Uncomp	NA	3	7	7	7	10	9	4
Chest Height	NA	8	6	3	9	7	5	6
Crotch Height	9	9	NA	15	5	NA	NA	7
Deltoid Point Height	NA	5	3	11	12	18	11	4
Ectoorbitale-Top of Head	NA	NA	NA	NA	NA	4	NA	NA
Elbow Breadth	NA	19	NA	8	NA	3	NA	8
Elbow Circumference	NA	10	NA	17	NA	10	NA	8
Elbow Depth	NA	10	NA	9	NA	5	NA	6
Eye Height, Sitting	11	5	NA	1	7	NA	NA	2
Foot Breadth Horizontal	NA	NA	NA	NA	NA	NA	NA	NA
Foot Length	NA	NA	NA	NA	NA	NA	NA	NA
Forearm Breadth, Flexed	NA	13	NA	7	NA	5	NA	7
Forearm Circumference, Flexed	NA	7	NA	15	NA	8	NA	8
Forearm Depth, Flexed	NA	6	NA	8	NA	3	NA	4
Glabella-Helmet Rim	NA	NA	NA	NA	NA	4	NA	NA
Hand Breadth	NA	NA	NA	NA	NA	NA	NA	NA
Hand Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Hand Length	NA	NA	NA	NA	NA	NA	NA	NA
Hand Thickness	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Breadth	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet) Length	NA	NA	NA	NA	NA	NA	NA	NA
Head (Helmet)Circumference	NA	NA	NA	NA	NA	NA	NA	NA
Heel Breadth	NA	NA	NA	NA	NA	NA	NA	NA

TABLE F-8 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Helmet Rim-Top of Head	NA	NA	NA	NA	NA	10	NA	NA
Hip Breadth, Compressed	4	3	NA	6	4	NA	NA	7
Hip Breadth, Uncompressed	11	7	NA	7	4	NA	NA	6
Knee Breadth	12	4	NA	12	3	NA	NA	12
Knee Circumference	9	12	NA	17	8	NA	NA	12
Knee Depth	3	14	NA	6	9	NA	NA	8
Knee Height, Midpatella	1	1	NA	2	1	NA	NA	2
Knee Height, Sitting	2	8	NA	2	4	NA	NA	6
Lateral Femoral Epicondyle Height	1	2	NA	1	1	NA	NA	2
Lateral Malleolus Height	4	4	NA	4	8	NA	NA	9
Menton-Sellion Length	NA	NA	NA	NA	NA	5	NA	NA
Menton-Top of Head	NA	NA	NA	NA	NA	3	NA	NA
Midshoulder Height	NA	4	2	6	4	5	7	4
Midshoulder Height, Sitting	7	3	6	7	3	6	4	3
Midthigh Breadth	3	7	NA	7	2	NA	NA	4
Midthigh Circumference	9	3	NA	10	13	NA	NA	7
Midthigh Depth	2	16	NA	17	19	NA	NA	11
Midthigh Height	2	3	NA	2	3	NA	NA	3
Neck Breadth	NA	NA	NA	7	NA	5	NA	20
Neck Circumference	NA	NA	NA	14	NA	7	NA	7
Neck Depth	NA	NA	NA	2	NA	5	NA	30
Neck Height, Lateral	NA	4	7	2	3	9	11	4
Popliteal Height	12	14	NA	7	15	NA	NA	5
Radiale-Stylion Length	NA	NA	NA	NA	NA	NA	NA	NA
Sellion-Back of Head	NA	NA	NA	NA	NA	5	NA	NA
Sellion-Top of Head	NA	NA	NA	NA	NA	5	NA	NA
Shoulder Circumference, Compressed	NA	10	6	19	11	20	13	17
Shoulder Circumference, Uncompressed	NA	11	13	18	11	26	9	17
Sitting Height	7	5	NA	6	4	3	NA	4
Stature	NA	5	3	4	3	3	2	4
Thigh Breadth, Crotch	2	8	NA	13	2	NA	NA	4

TABLE F-8 (continued)

	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 7	LAYER 8
Thigh Circumference, Crotch	2	3	NA	4	13	NA	NA	7
Thigh Clearance	4	11	NA	6	6	NA	NA	4
Thigh Depth, Crotch	9	15	NA	10	15	NA	NA	11
Trochanteric Height	2	1	NA	3	2	NA	NA	3
Vertical Trunk Circumference	10	1	9	11	14	18	12	25
Waist Breadth	1	6	5	4	6	4	7	4
Waist Circumference, Omphalion	13	3	21	21	2	10	13	14
Waist Depth	13	6	7	8	3	12	5	4
Waist Height, Omphalion	3	0	7	5	4	2	6	3
Weight	3	1	0	7	2	0	1	3
Wrist Breadth	NA	11	NA	4	NA	2	NA	3
Wrist Circumference	NA	21	NA	7	NA	2	NA	2
Wrist Depth	NA	14	NA	5	NA	2	NA	4